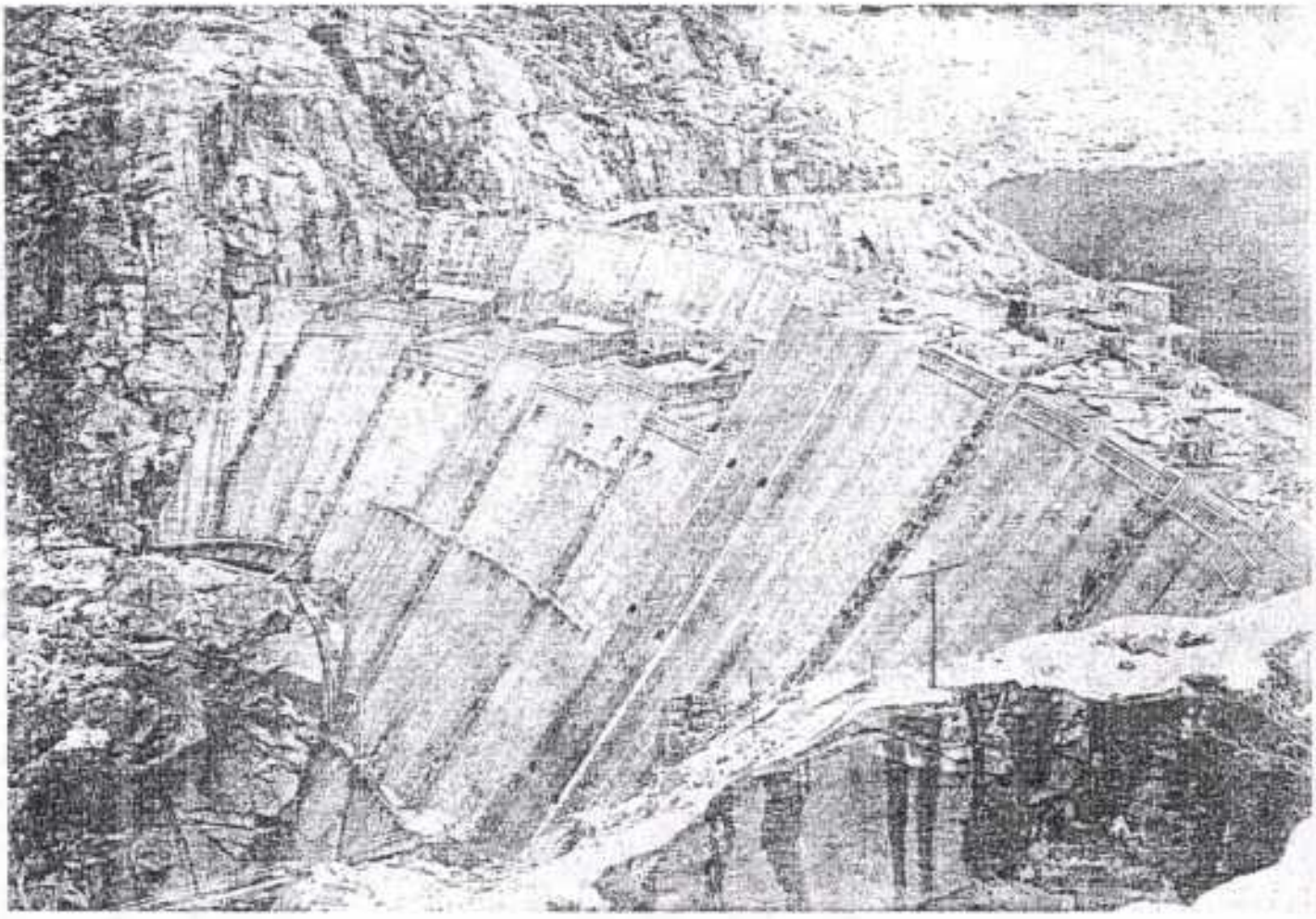
Restoring Hetch Hetchy



prepared by
Assembly Office of Research

No. 0220-A

RESTORING HETCH HETCHY

Frontispiece

"I predict that long before Hetch Hetchy would possibly be needed for a water supply for San Francisco, the travel thither will have become so great and its needs as a campground, particularly in relation to the surrounding park so urgent, as to preclude the possibility of its use as a reservoir. What I am opposed to is the determination right now that the Hetch Hetchy Valley shall be flooded fifty years from now. I feel that the decision ought properly to be reserved for those who live fifty years hence. We surely can trust that their decision will be a wiser one than we can make for them."

William E. Colby
Sierra Club
1909

"Plainly, it is an absolute impossibility to obtain a softer, better or more pure water supply than from the upper Tuolumne and plainly it is impractical to secure a cleaner reservoir site or one that possesses a larger proportion of bare granite walls all the way between the high and low water limits."

John Freeman
Consulting Engineer
1912

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Prepared by the Assembly Office of Research
California State Legislature
State Capitol
Sacramento, California 95814
June, 1988

INTRODUCTION

The Hetch Hetchy Valley has had a turbulent geological and political history. Initially, it was created by fire and ice, then saved in a great political campaign as a national park. Finally, it was allowed to be dammed as a national symbol to demonstrate that the creation of national parks did not mean that park resources would be locked up forever. As that symbol, Hetch Hetchy was a failure; the decision on Hetch Hetchy was just too close to the days of slaughtering the buffalo and not close enough to the days when you can't get a reservation to stay at Yosemite.

The recommendation to restore Hetch Hetchy to its natural state stems from the notion that the recreational and esthetic values are so great that it would be worth the cost of replacing the current water and power system. Our society makes decisions similar to this when we purchase parklands; essentially we decide that the public recreation value outweighs the value of the land in private ownership. The Hetch Hetchy case is not different in concept, just in the magnitude of the existing investments.

The greatest difficulty in researching Hetch Hetchy is that there is very little information on Hetch Hetchy: what it was, what it is, and what it could be. The small handful of people who knew Hetch Hetchy are gone and they did not leave comprehensive written evaluations of the valley. What they left is a small number of photographs buried in attics and archives, but most of these are of one part of the valley. How the rest of the area originally appeared is poorly documented. Even finding modern photographs of these "ignored" areas is difficult, largely because the photography and guide books on Yosemite National Park concentrate on natural areas readily accessible to the public.

For the people of the 1980's, the issue of restoring Hetch Hetchy involves trade-offs between several very important public needs: recreation, aesthetics, high quality drinking water supplies, hydroelectric energy, and cost. A proper evaluation of these issues is not unlike the evaluation that was made by Congress in 1913: what are the costs; what are the benefits; where does San Francisco get its water; what about the energy; how could the valley be used?

This report is divided into three general parts. The first set of chapters describe Hetch Hetchy, starting with a history of the Yosemite National Park and ending with a comparison of Hetch Hetchy to Yosemite. Given the lack of information on Hetch Hetchy, the Hetch Hetchy description may be the report's most significant contribution. The second set of chapters describe the San Francisco water system, starting with a history of the decision to allow the dam and ending with a description of replacement alternatives. The last chapter contains conclusions.

Chapter 1

HISTORY OF YOSEMITE NATIONAL PARK

The great granites of Yosemite and Hetch Hetchy were formed deep in the earth as the North American Continent overrode the floor of the Pacific Ocean. In the building of the Sierra Nevada Mountains, these granites were pushed up and material on top was eroded away. The Merced River then cut a typical "V" shaped river valley through what is now the Yosemite Valley. Twelve miles north, the Tuolumne River cut a "V" shaped valley through Hetch Hetchy. Exhibit 1 shows the location of the two valleys.

During the ice ages, slowly moving, enormous glaciers gouged out thousands of feet from the bottoms and sides of the valleys. Huge bolder fields, called glacial moraines, were created at the downstream faces of the melting glaciers. After the glaciers retreated, lakes were formed behind the boulder fields. In time, the lakes filled with sediment, creating flat mountain meadows.

Hetch Hetchy Valley was occupied by Pah Utah Indians of the eastern Sierra slope when first visited by a European in 1850. The Pah Utahs had recently gained control over the valley from the Big Creek Indians who lived on the western slope. The valley was prized because of the abundance of oak acorns, which the Indians used to make flour.[1] In 1851, a troupe of United States Cavalry entered Yosemite Valley while chasing marauding Indians. After that, the fame of Yosemite spread quickly.

In the 1860's, California's geological experts believed that Yosemite and Hetch Hetchy Valleys were formed when the valley floors "dropped because of the removal of underlying support." The young John Muir shocked the scientific establishment when he demonstrated that the valleys were formed by ancient, now dead glaciers.

In Europe, great national resources had been held since the Middle Ages as private hunting grounds and forests. Public ownership of such resources was just surfacing as a political issue. In the United States, visionary people pursued the need to create public parks, thereby breaking away from the European pattern. In the first practical application of the concept of a national park,[2] President Abraham Lincoln signed a bill which deeded the Yosemite Valley to the State of California, in 1864. The bill required the state to preserve and protect the valley in a natural and undisturbed condition.

In 1890, the Yosemite National Park was created. The park included the watersheds of the upper Merced and Tuolumne Rivers, including all of the Hetch Hetchy Valley. The park surrounded, but did not include, the Yosemite Valley lands which had been granted to California in 1864. The United States Army was the park administrator.[3] After the turn of the century, it became evident the state had done a poor job of developing the roads and visitor facilities of Yosemite. After a long political fight, the California Legislature voted in 1905 to return Yosemite Valley to the federal government. In 1906, Congress accepted the return of the park.[4] In 1916, the National Park Service was created and given the responsibility to administer the park.

In 1901, the Secretary of Interior asked Congress to clearly define when rights-of-way through National Parks may be granted. In a bill carried by a Congressman Marion DeVries of Stockton, Congress said:[5]

"....that the Secretary of the Interior [is] authorized and empowered, under regulations to be fixed by him, to permit the use of rights of way through . . . Yosemite, Sequoia and General Grant National Parks, California, for . . . canals, . . . and reservoirs for . . . the supplying of water for domestic, public or any other beneficial uses."

This noncontroversial act was soon to be the cornerstone upon which San Francisco would build Hetch Hetchy.[6] In 1913, Congress gave specific approval to San Francisco to dam Hetch Hetchy.

In 1986 the Congress placed the main stem of the Tuolumne River above the New Don Pedro Reservoir into the federal Wild and Scenic Rivers System. The only portions of the river that were exempted were those where San Francisco has water facilities. See Exhibit 2. The major recreational uses of the river between San Francisco's facilities and the New Don Pedro Reservoir are whitewater rafting and fishing.

Exhibit 1

Location of the Hetch Hetchy & Yosemite Valleys

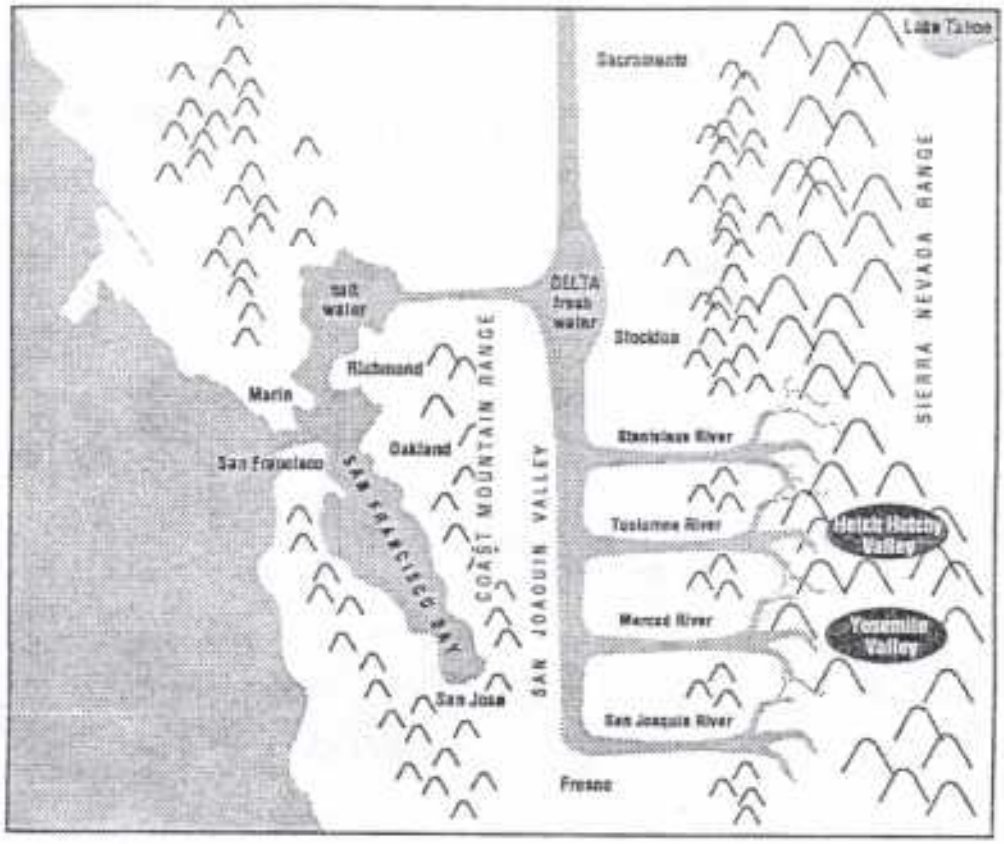
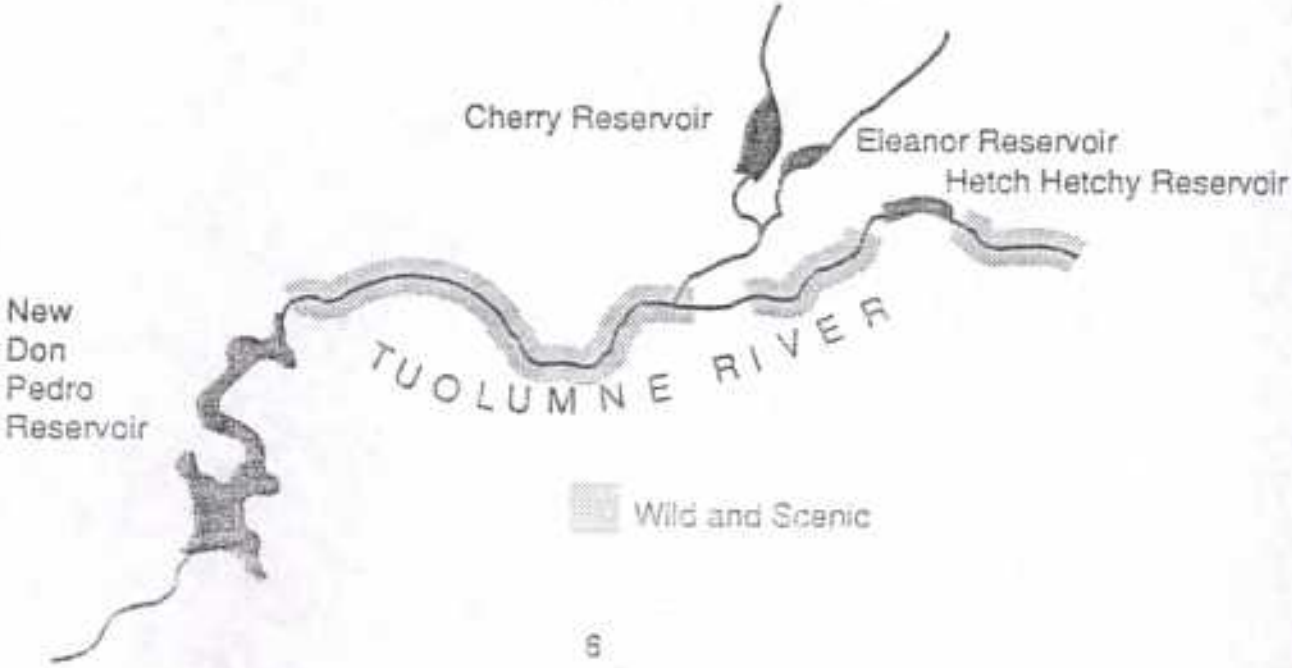


Exhibit 2

Portions of the Tuolumne River in the Federal Wild and Scenic River Act



Chapter 2

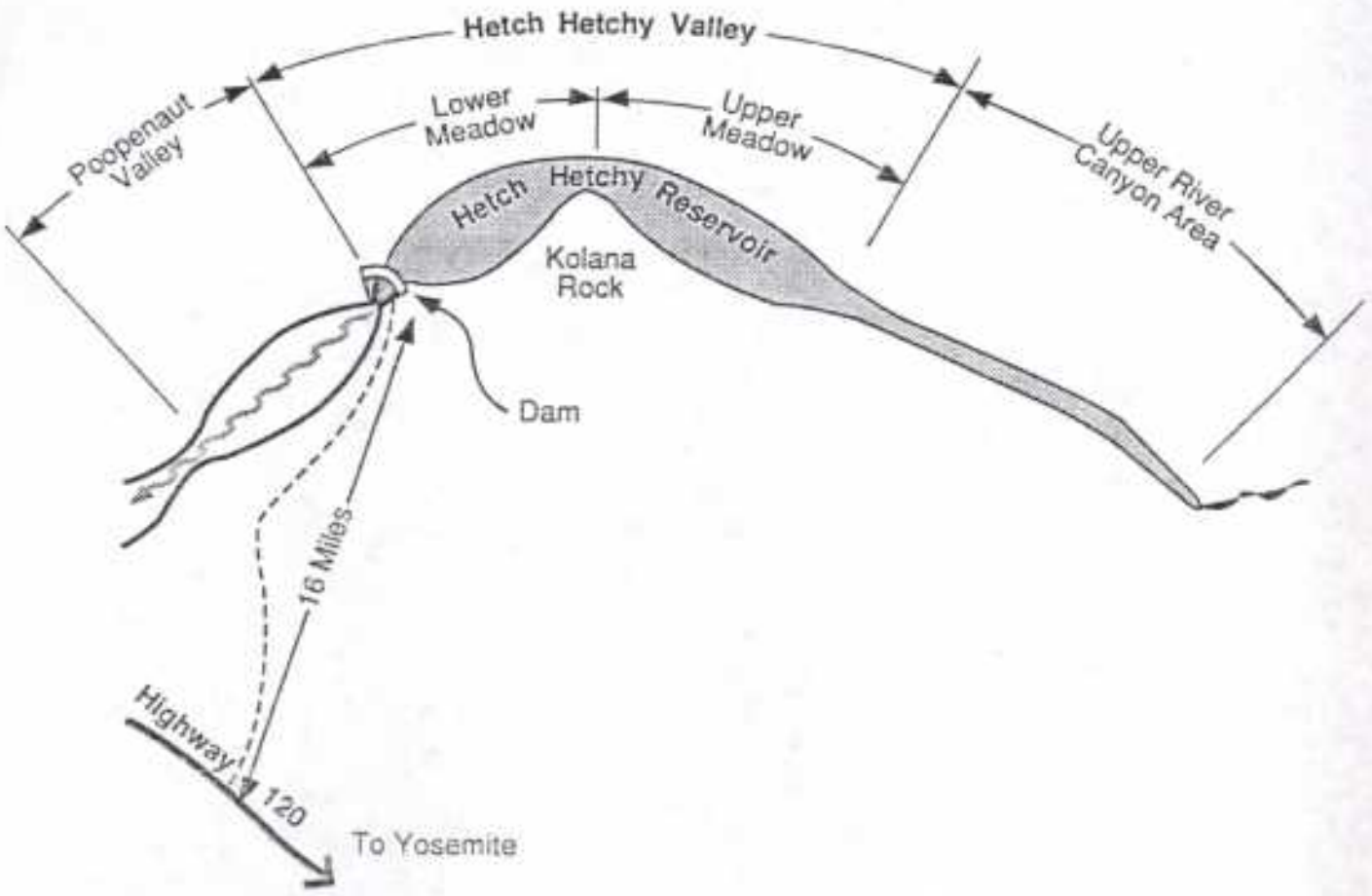
A DESCRIPTION OF HETCH HETCHY

A schematic of the Hetch Hetchy area is shown in Exhibit 3. The area is divided into four parts. The area immediately downstream from the dam is the Poopenaut Valley. The Hetch Hetchy Valley itself is divided into lower and upper valleys by the intrusion of Kolana Rock, a large granite dome on the south side. Above the Hetch Hetchy Valley is an upstream river canyon area. These four areas will be described sequentially, in the order that a visitor would normally see them.

A small scale version of Exhibit 3 will be shown with each photograph included in this report in order to show the location of the camera and the view seen by the camera (camera angle).

Exhibit 3

Hetch Hetchy Area



Poopenaut Valley

There are three roads from California's Central Valley to the Yosemite Valley: Highway 41 approaches from Fresno on the south ridge; Highway 140 runs up the river canyon from Merced; and Highway 120 approaches on the north ridge from the Stockton-Manteca area. The road to Hetch Hetchy leaves from Highway 120, before the visitor reaches the northern Yosemite Park entrance station. The Hetch Hetchy road is a moderately narrow, winding, two lane, paved road. The ridge top is similar in elevation to Yosemite, and thus has forest vegetation. About five miles before Hetch Hetchy Reservoir, the road begins to descend into the canyon, with the Tuolumne River on the left. The vegetation begins to change to upper foothill vegetation as the elevation drops. The first long distance view is of the Poopenaut Valley.

Other than its unusual width, the Poopenaut Valley is a typical river canyon at an elevation of 3,400 feet in the Sierra. Man has had little impact on the valley. The surrounding hills have lots of granite, but no imposing granite structures or vertical walls. The canyon slopes are moderate and the hills are rounded. Hillsides facing south have vegetation that is typical of the higher elevation foothills: scraggly digger pines, live oak trees, ceanothus and manzanita. Along the river there are ponderosa pines, which are typical, low elevation forest trees. Hillsides facing north have the same vegetation, but there are more varieties wherever it is wetter and more protected.

A visitor's first impression of the Poopenaut Valley is probably that the valley is not very interesting, being dry and undoubtedly hot in the summer. The areas close to the river are, however, very pretty. While most of the river flows bypass the Poopenaut Valley for hydroelectric generation, fishery flows are maintained in the river. The Park Service says that the annual recreational use of the valley is about 3,000 people, mostly fishermen. A 1934 photograph of the Poopenaut from the damsite looking downstream is shown as Exhibit 4. A photograph of the lower Poopenaut, just upstream from the potential Poopenaut damsite, is shown as Exhibit 5.

The Lower Hetch Hetchy Valley

The road to Hetch Hetchy ends on the southern side of the dam at a small public parking lot. San Francisco maintains a small number of cabins near the dam, mostly used to house maintenance personnel. There are no public services, except for restrooms and drinking fountains. The lands around the reservoir are open to the public. The public may fish from the reservoir's banks, but may not boat on the reservoir. A small walk-in campground is being constructed near the parking lot. A National Park trail leaves the parking lot, crosses the dam, and travels half way around the north side of the reservoir. There are no trails on the south side near the reservoir.

The lower Hetch Hetchy Valley is about 1 3/4 miles long, extending from the Hetch Hetchy damsite to Kolana Rock, the large granite dome on the south side. Exhibit 6 shows the classic view of Hetch Hetchy as seen from the lower valley. Before it was flooded the flat floor of the lower valley was about 2,000 feet in width, with half in meadow and half sandy and dry. The meadow was about one mile in length and contained a large variety of grasses, ferns and wildflowers. The meadow was open, almost like a farmer's grain field. This meadow was timbered along its edges with ponderosa pine. The Tuolumne River ran through the middle, with its banks fringed with poplar, willow, thickets of dogwood and azalea.[7] There was little broken rock at the base of the walls. Near the upper end of the meadow, on the south side, was a small granite hill, which rose 130 feet above the valley floor. There was a small pond between the granite hill and the south wall. A visitor on the valley floor would have had a spectacular view of the valley and the surrounding walls.

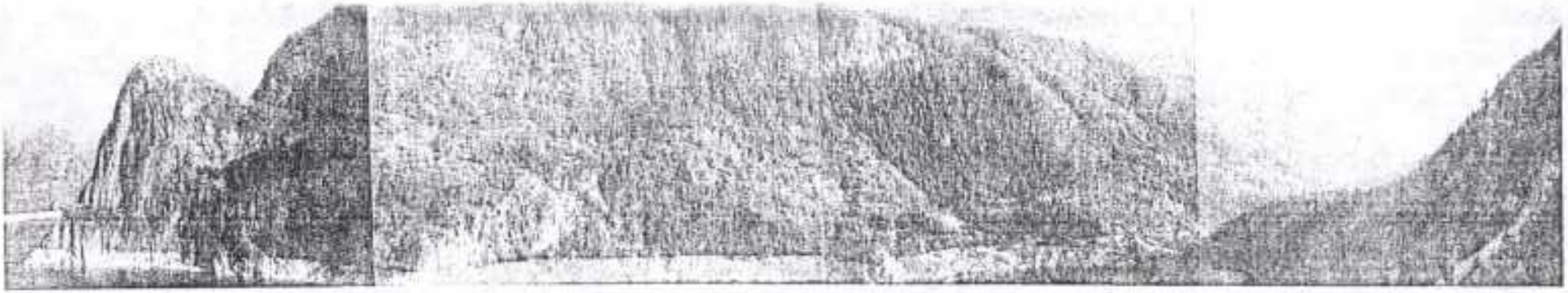
The glaciers which carved Hetch Hetchy moved in a fairly straight line through the the upper valley. In moving into the lower valley, the glaciers were squeezed between Kolana Rock on the south and the hard granite wall on the north. Then, the glaciers had to make a turn to the left, causing huge grinding forces to be exerted upon the north wall. Because of these movements, the largest impacts of the glaciers were upon Kolana Rock and the first mile of the north wall.

The south side of the lower valley is shown on the upper photograph on the following page. Kolana Rock is on the left and the dam is on the right. Clearly, the most dominant feature is the Kolana Rock, which divides the valley into two parts by intruding into the valley. This granite dome is about one-quarter worn away on the valley side. The lower portion of the rock has a large amount of glacier-polished granite. The ridge behind Kolana that forms the rest of the south side is 3,400 feet above the

Kotana Rock

Quarry

Dam

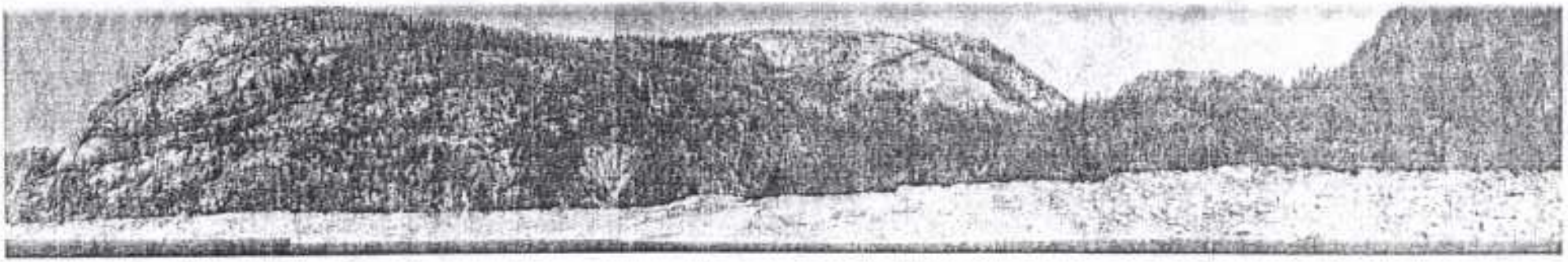


Fold-Out A

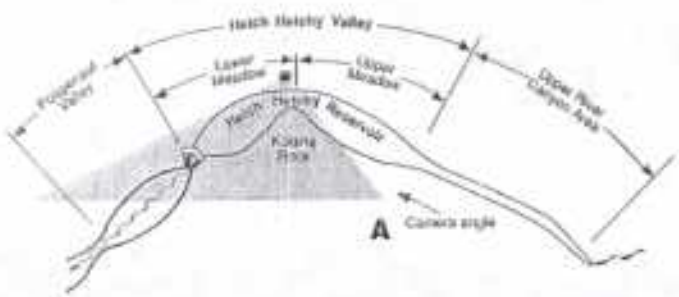
LeConte Point

Tiltill Creek

Rancheria Creek



Fold-Out B



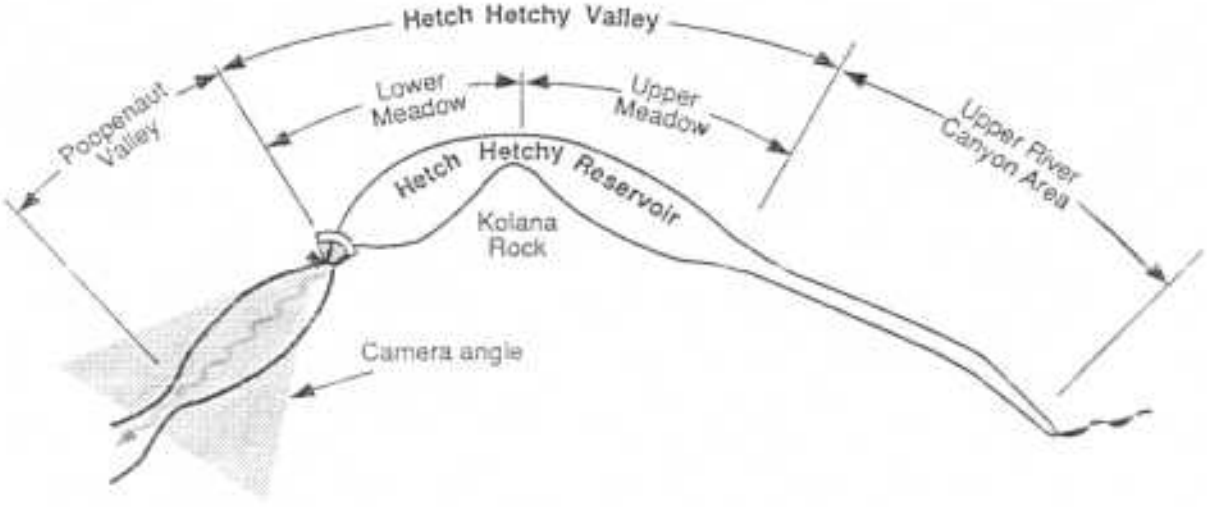
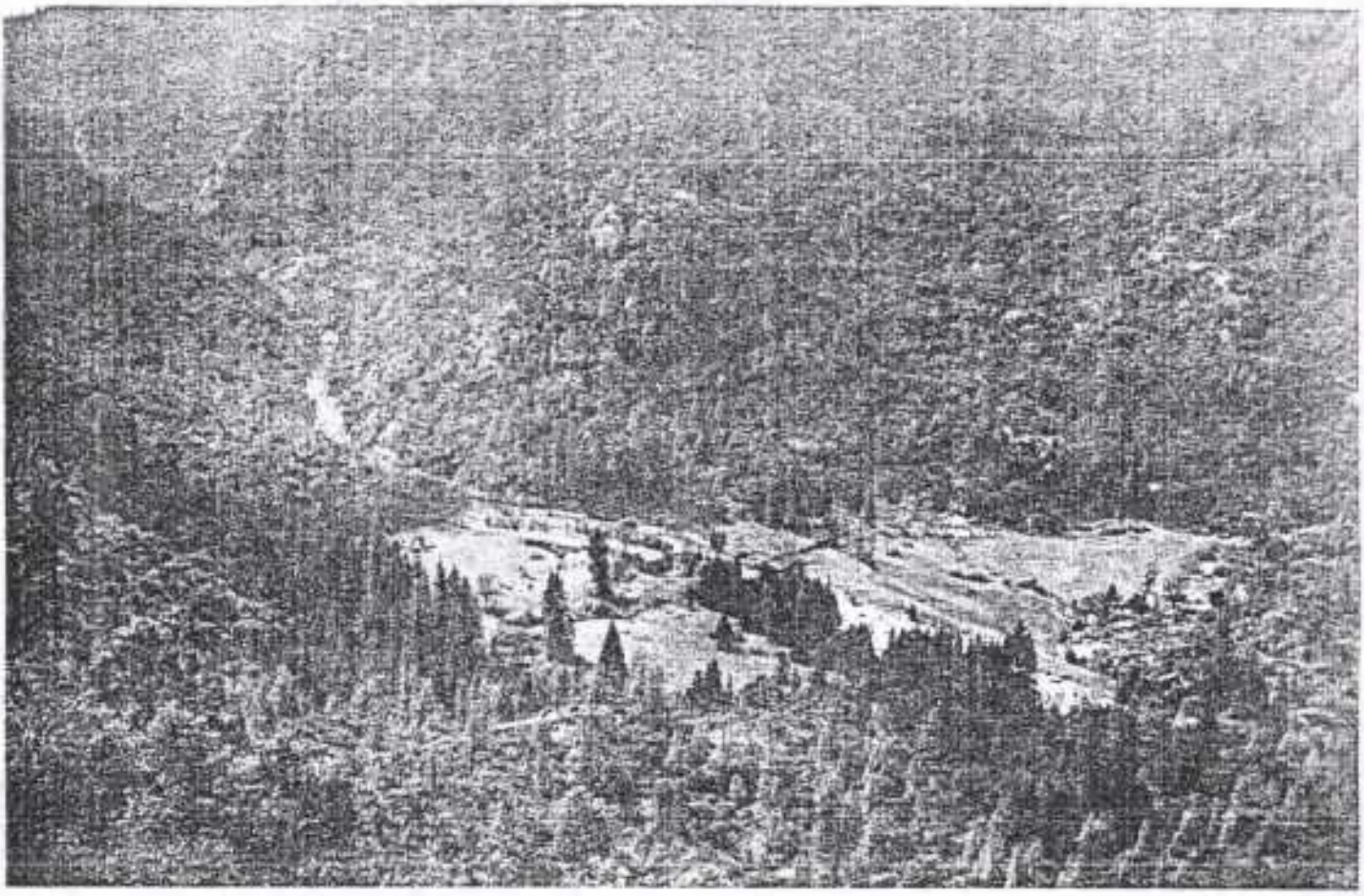


Exhibit 4

Poopenaut Valley from the Dam site, 1934. Surveying for the Dam's enlargement (the road to the dam is in the upper left).



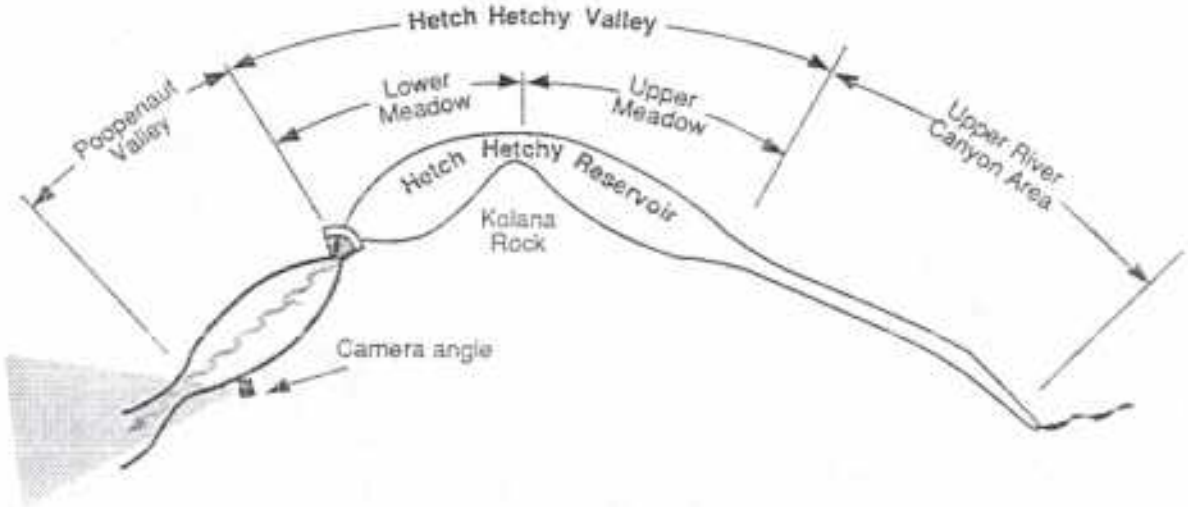
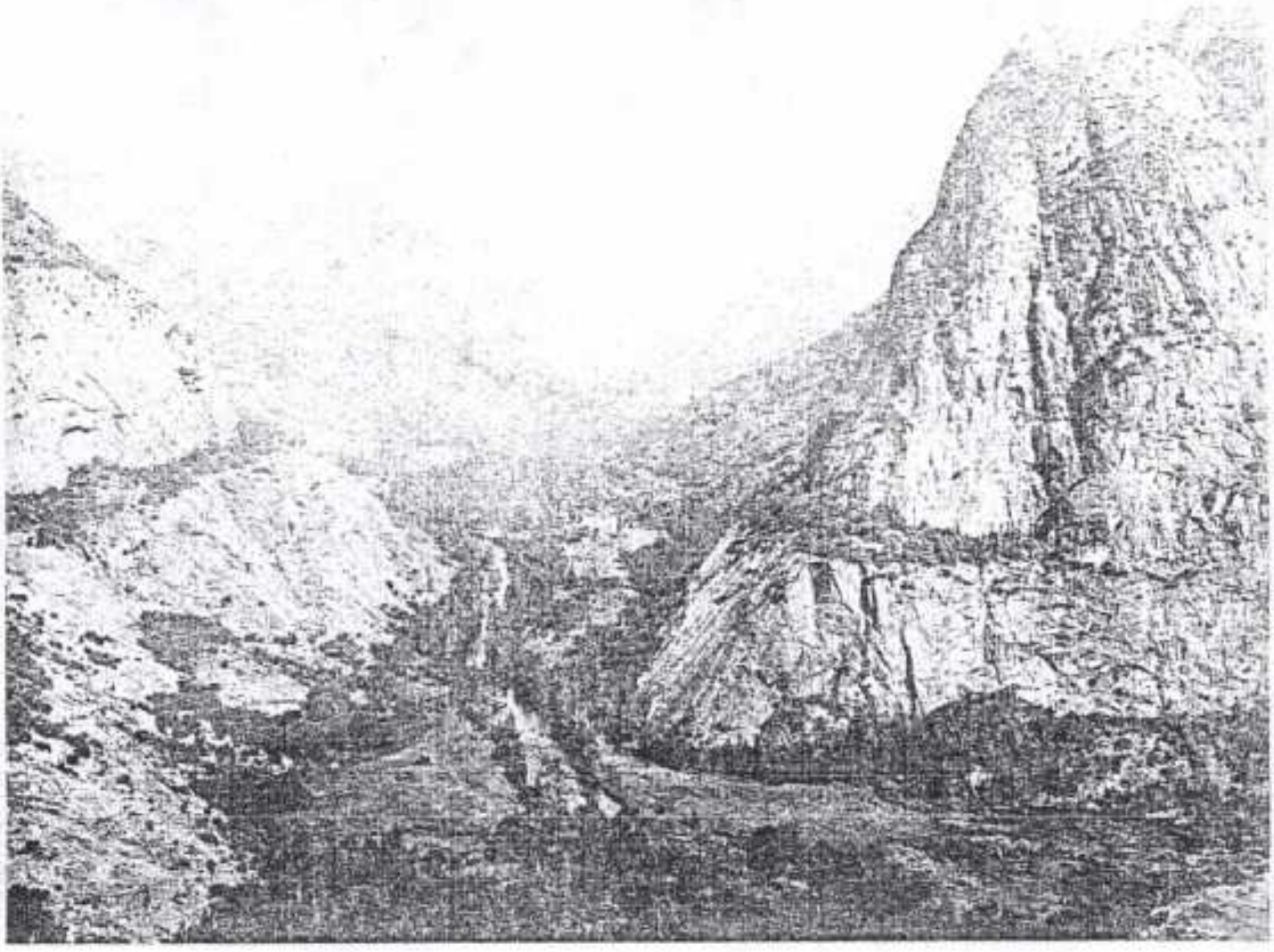


Exhibit 5
Lower Poopenaut Valley



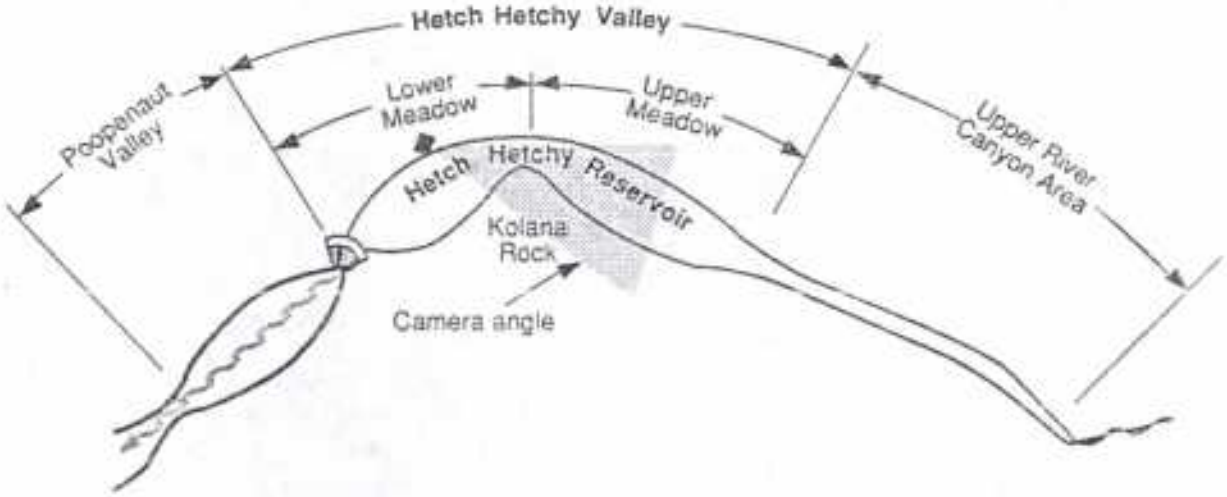


Exhibit 6
The Classic View of Hetch Hetchy

valley floor. As seen in the foldout, the reservoir is 130 feet below its maximum level, thereby leaving a wide "bathtub" ring. The road to Hetch Hetchy can be seen on the right, above the dam. Three-quarters of the way from Kolana to the dam is a quarry which was used to supply some of the rock for the dam.

The glacier-scoured north wall opposite Kolana is shown as Exhibit 7. This north wall presents a mile-long mass of granite that rises precipitously from the valley floor. The most striking feature of the wall is its mass and extent. The highest feature on the north wall of Hetch Hetchy is the small Hetch Hetchy Dome, which is 2,645 feet above the valley floor. Protruding from the north wall, west of the dome, is a small version of Yosemite's El Capitan, with Hetch Hetchy's being half as high and one-third as wide. The apparent similarity to El Capitan is lost when this outcropping is viewed from either the valley floor immediately below or from the east. The north wall has noticeably wide ledges which extend in generally horizontal directions. The ledges are primarily covered with oak, bay and incense cedar trees. The National Park trail that travels along the north side of the reservoir is located on one of these ledges.

The rock formations in the remainder of the north side in the lower valley are reminiscent of Yosemite's north wall near the west entrance: lots of granite, but no significant, single rock structures. An old photograph of this part of the lower valley is shown as Exhibit 8. A composite photograph of the west half of the lower valley is shown as Exhibit 9.

There are two major waterfalls in the lower valley, both flowing over the edge of the north wall to the valley floor below: Wapama and Tueeulala. These are shown in Exhibit 10. The larger waterfall, Wapama Falls, is part of Falls Creek. The total elevation drop of Wapama is about 1,600 feet, approximately two-thirds of the drop of Yosemite Falls. Wapama is crowded against the eastern side of Hetch Hetchy's el capitan. As a result, the full drop of Wapama can be seen only from immediately below. Wapama does not fall vertically, but instead tumbles ferociously downward at about a 70 degree angle. Wapama makes an enormous amount of noise and produces a lot of spray. Wapama is not a classic, vertical drop waterfall, but it is very impressive and very captivating.

On the western side of el capitan, Tueeulala Falls drops about 1,200 feet to the valley floor. The upper one-third of this drop is vertical. The middle one-third tumbles and splatters over solid granite. The last one-third flows over and through rock talus to the meadow below. When it is flowing, Tueeulala is very pretty, but it has a tiny drainage area, meaning that the flow is small to nonexistent in dry weather.

The Tuolumne River, which flowed through the Hetch Hetchy Valley, had an average width of about 200 feet according to San Francisco topographic surveys. As shown in Exhibit 11, the lower part of the Hetch Hetchy Valley terminated in a very narrow granite canyon where the river was about 50 feet wide. During periods of high river flow, the narrow outlet caused portions of the very flat valley to flood. Exhibit 8, shown previously, showed that there was a jumble of logs at the northern edge of the lower meadow, giving evidence that the lower valley would periodically have ten or more feet of flood water. If this was true, the upper valley also would have flooded, at least partially. Other photographs show that the lower meadow was swampy, at least part of the year. This was probably the reason that trees had not substantially populated the lower meadow. The lower meadow's river banks were not very definite, probably due to the constriction at the valley's outlet.

The existing vegetation in the lower valley is similar to the Poopenaut, but there are more varieties. In the drier areas, the digger pines and manzanita predominate. Where it is a little wetter there are oaks. Where there is a good supply of water there are oaks, California laurel (bay trees), incense cedar, ponderosa pines and small amounts of poison oak. On the north-facing wall, there are additional associations of varieties, such as firs. At the higher elevations, the vegetation turns to true forest types.

The lichens on the granites that make up the reservoir's "bathtub ring" have been killed, leaving these rocks their natural whitish grey. These rocks are "clean" as if they had just been quarried. These rocks do not appear to have been discolored by chemical deposits as occur in reservoirs where the water is mineralized.

The old photographs of Hetch Hetchy provide a significant insight into what the photographers thought was important about Hetch Hetchy. The vast majority of the photographs included all or part of the one Yosemite-like view that Hetch Hetchy has: the panorama that includes Kolana on the right, the meadow in the foreground, and the polished granite north wall on the left. This view is possible over an

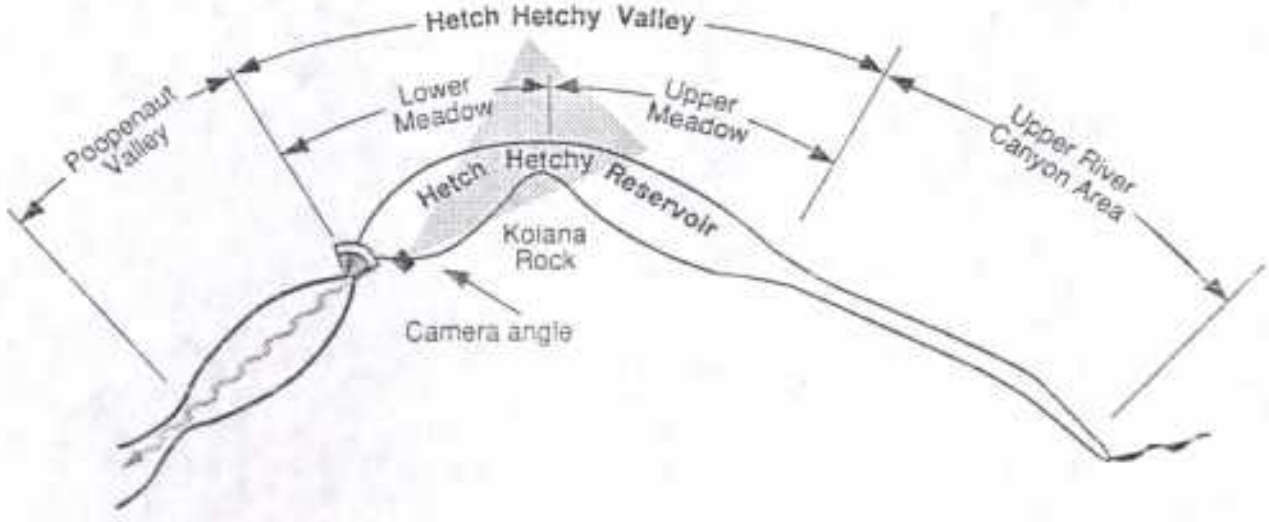
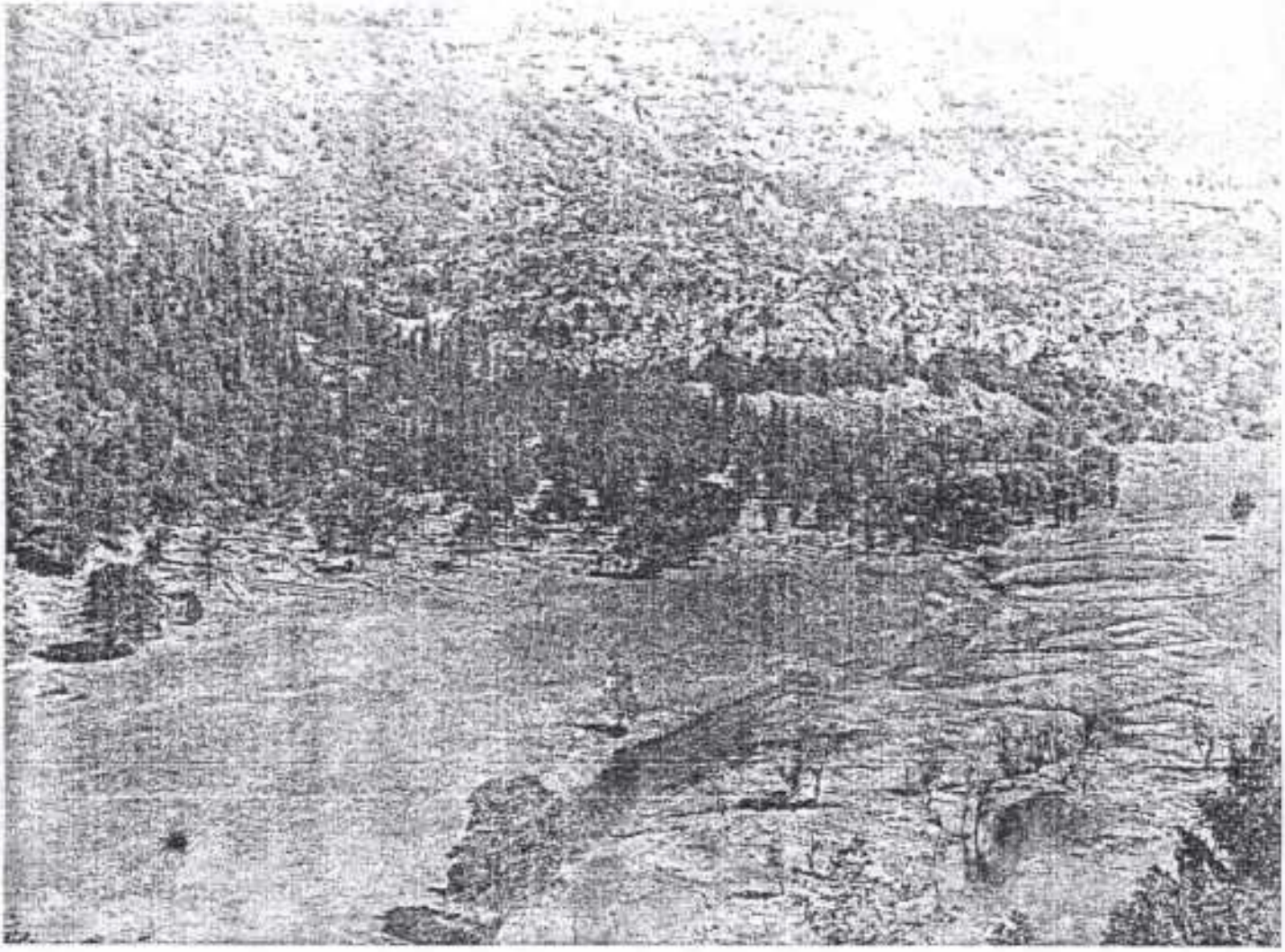


Exhibit 7
The North Wall
Early Morning



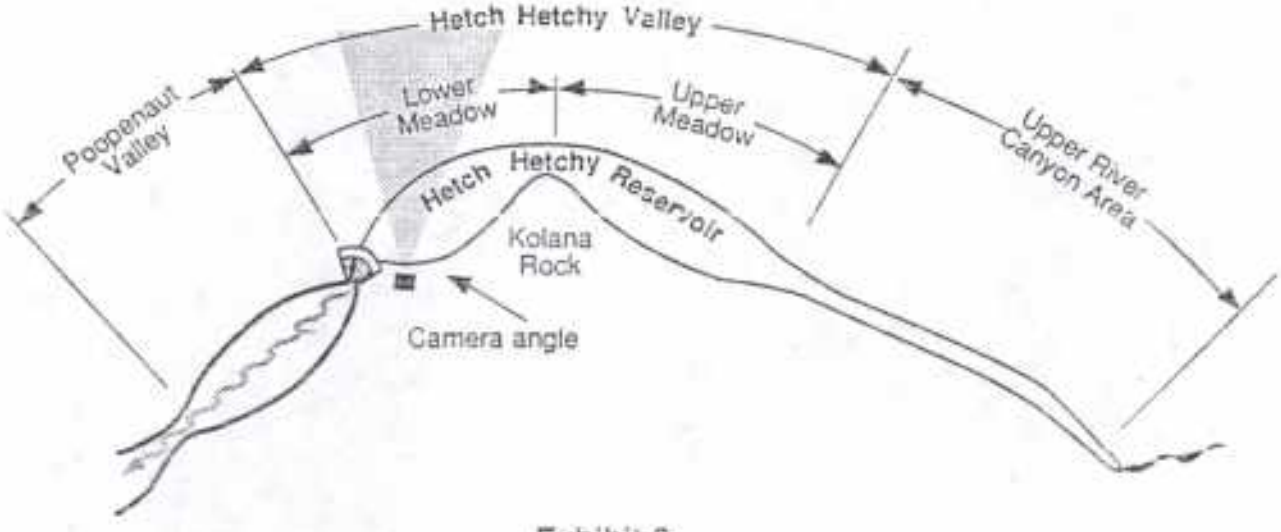


Exhibit 8
West End of the North Wall

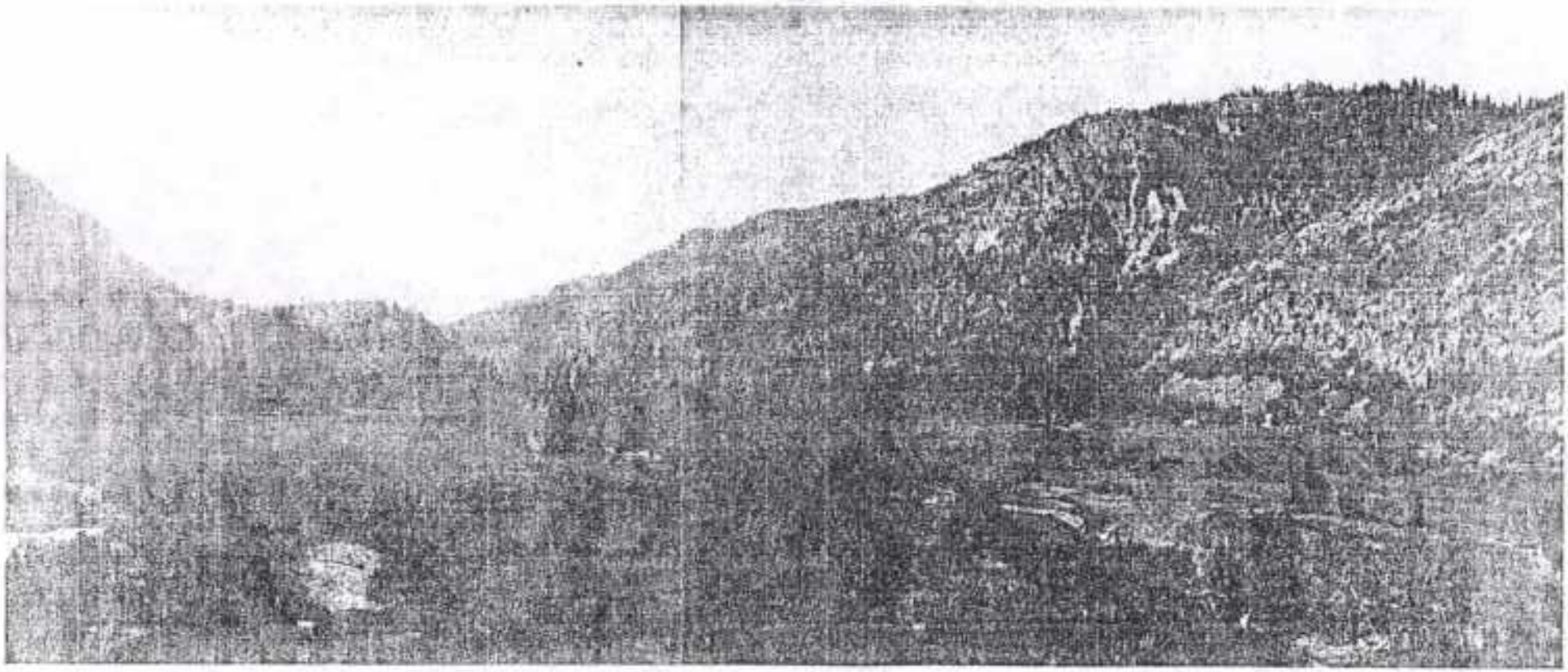
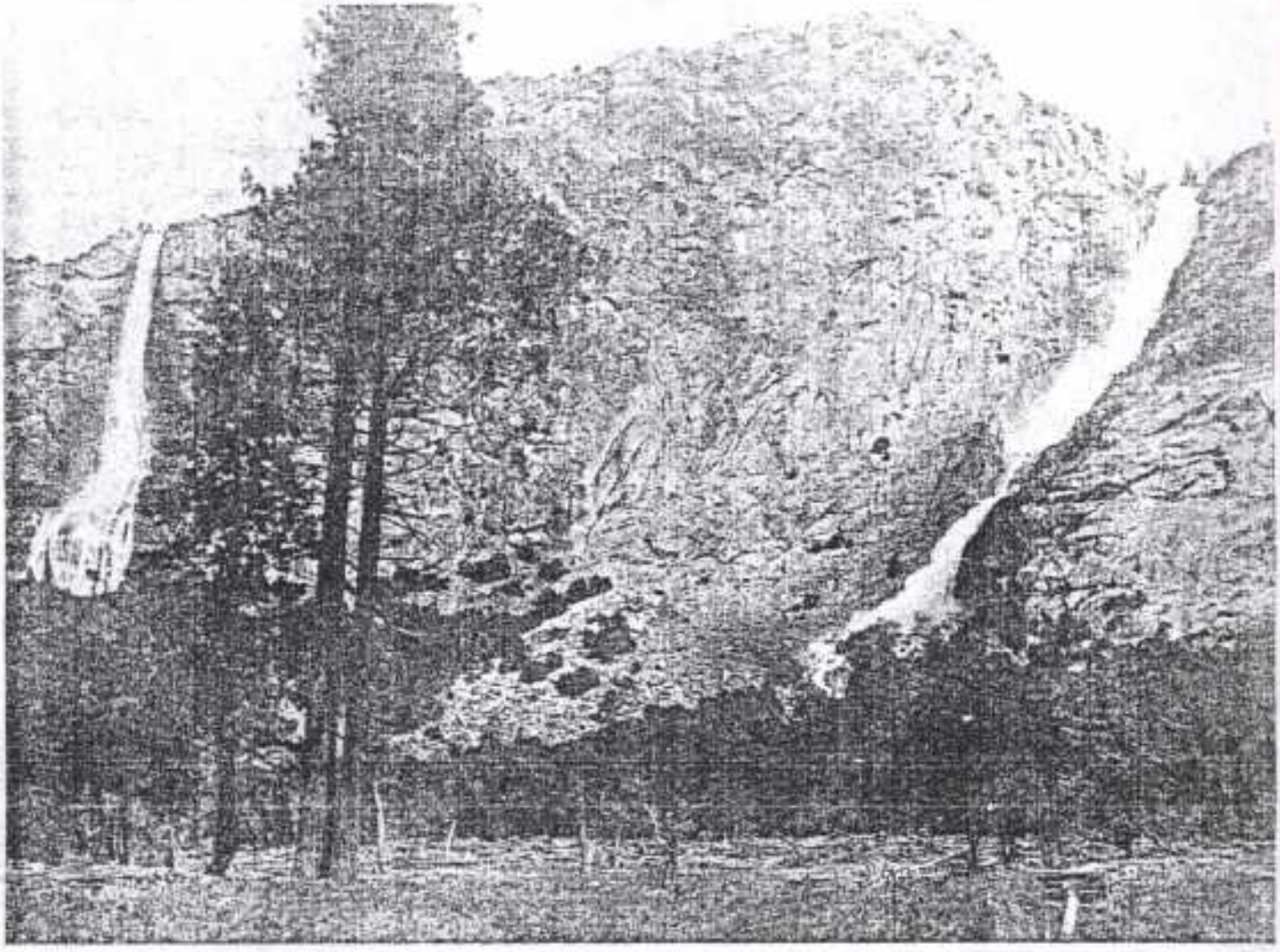


Exhibit 9

Composite Photograph of the West Side of the Lower Hetch Hetchy Valley

Joseph LeConte, 1908. University of California Bancroft Library, Call Number 1971.34



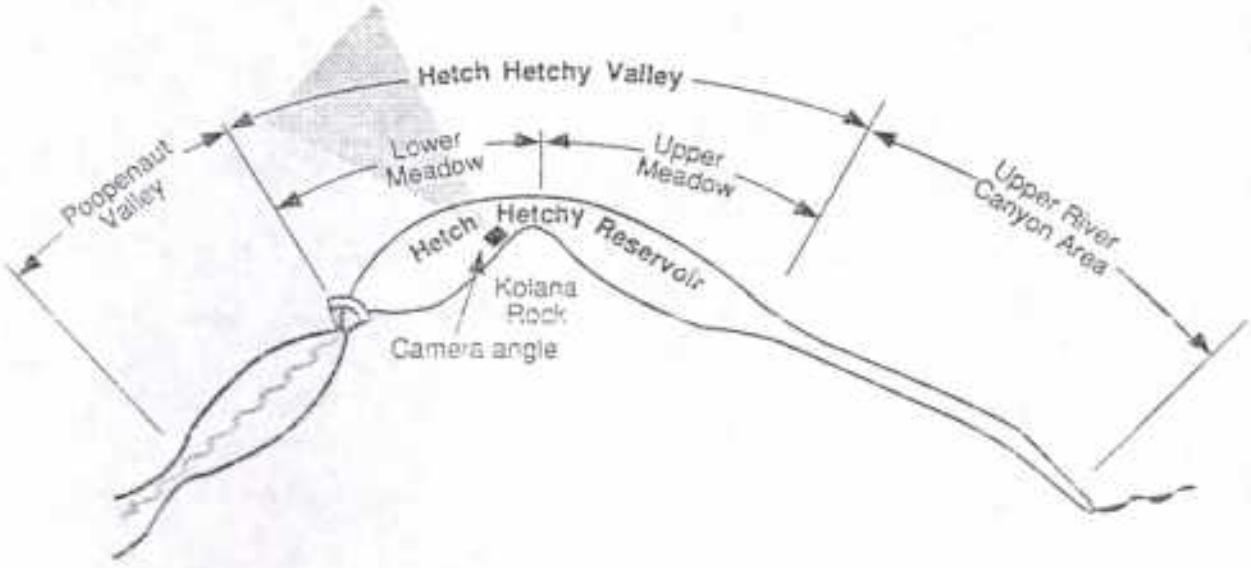
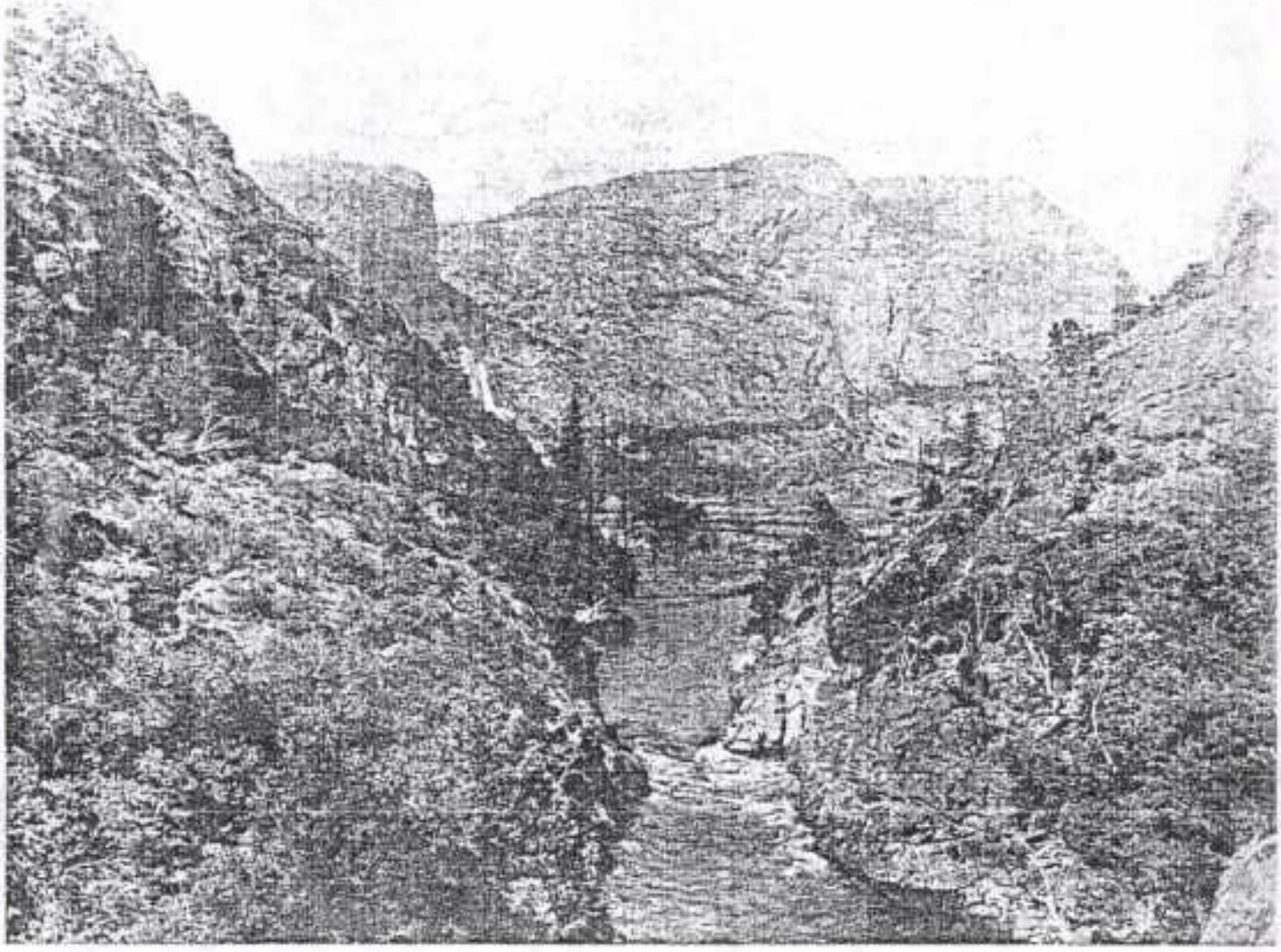


Exhibit 10
Tuseulala and Wapama Falls



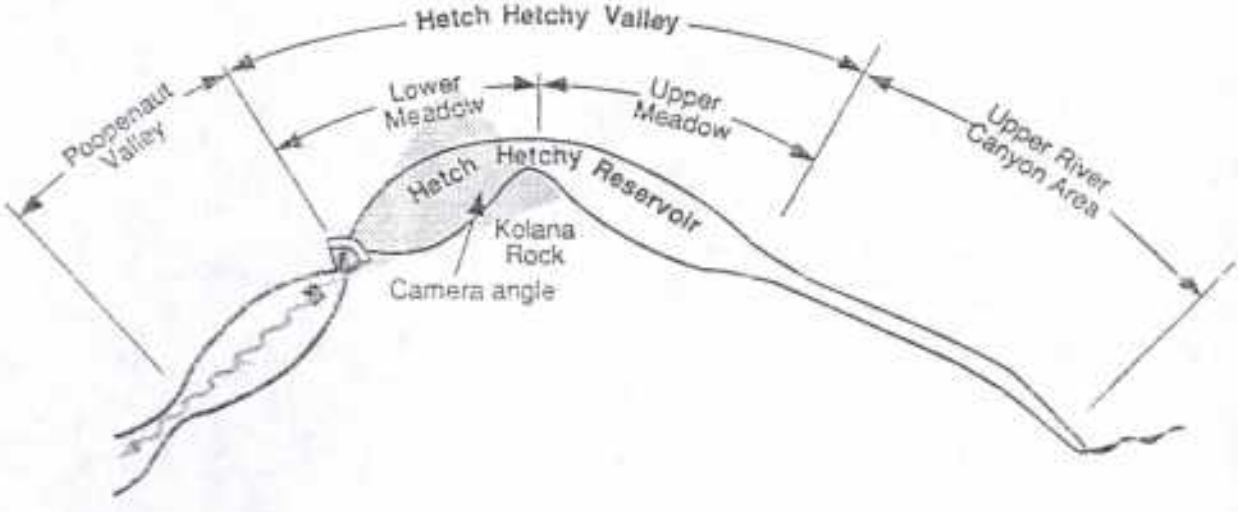


Exhibit 11
At the Dam Site Looking Upstream

arc that stretches for about a mile. The view clearly offers the photographer a wonderful "framing," drama, and range of light values. Sierra Club member Joseph LeConte took the best photographs of Hetch Hetchy in 1908, in the middle of the dam controversy. He took more than 60 large negative photographs of the whole valley. Most of his photographs of large panoramic views were of all or part of this single view of the lower Hetch Hetchy Valley. Most of the other photographs tend to be non-panoramic views, such as of oak groves, the river, small waterfalls, and creeks.

The Upper Hetch Hetchy Valley

The "slot" between the lower valley and the upper valley is very impressive because of its narrowness, the large amount of glacial polish, and the huge vertical elevations. On the lower parts of Kolana, the polish is exceptional. The vegetation on the ledges is vigorous and lush, sometimes appearing to grip tenaciously to a tiny spot of growing surface.

The meadow of the upper valley was slightly higher than the lower meadow. The upper meadow was about 1,200 feet wide and was more densely wooded, primarily with ponderosa pine. The ponderosa pines like to be near the water but they need to be several feet above saturated soil. Because of the pines we can guess that the upper meadow had better drainage. Old photographs show that the river banks were better defined. There were some meadow areas, but not as extensive as in the lower valley. There was a large variety of trees in the meadow and lots of ferns and grasses. The trees were well spaced, giving a spacious rather than crowded perspective.

The vertical rise of the south wall is spellbinding, rising over 4,000 feet from the valley floor. There are huge amounts of glacial polish, although there are few significant, single granite structures.

The north side of the upper valley is shown in the bottom photograph of the foldout . This composite photograph stretches from the slot on the left to near where the Tuolumne River enters (off the photograph to the right). For perspective, the vertical elevation in the exhibit is about one-half mile. The north side widens into a huge, curved amphitheater with less steep slopes. LeConte Point is the granite dome on the left. Tiltill Creek flows down through the center of the photograph. Rancheria Creek begins at the plateau in the middle-right of the photograph. Rancheria starts at the top with impressive falls. The creek then spreads out and sheets over a glacier-polished granite slab. The sheeting is about 200 feet wide and 300 feet long. The creek then flows violently down a very unusual, vertical-walled canyon that runs from the plateau down into the reservoir. As shown in Exhibit 12, this canyon appears as if it were cut into the granite with the tip of an 80 foot wide chain saw. The cut is almost perfectly straight from the plateau to the reservoir. Half-way down, the canyon is about 150 feet deep. As the canyon runs into the reservoir, the canyon appears to be filling with boulders that are washed down. Since there is little sign of water wear on the granite at the top, the canyon material must be soft or be an unusually fractured fault zone. The creek is very impressive.

The vegetation of the upper valley is similar to that of the lower valley. The trail around the north side of the reservoir splits, with one fork going up Tiltill Valley and one going north-east from Rancheria Creek.

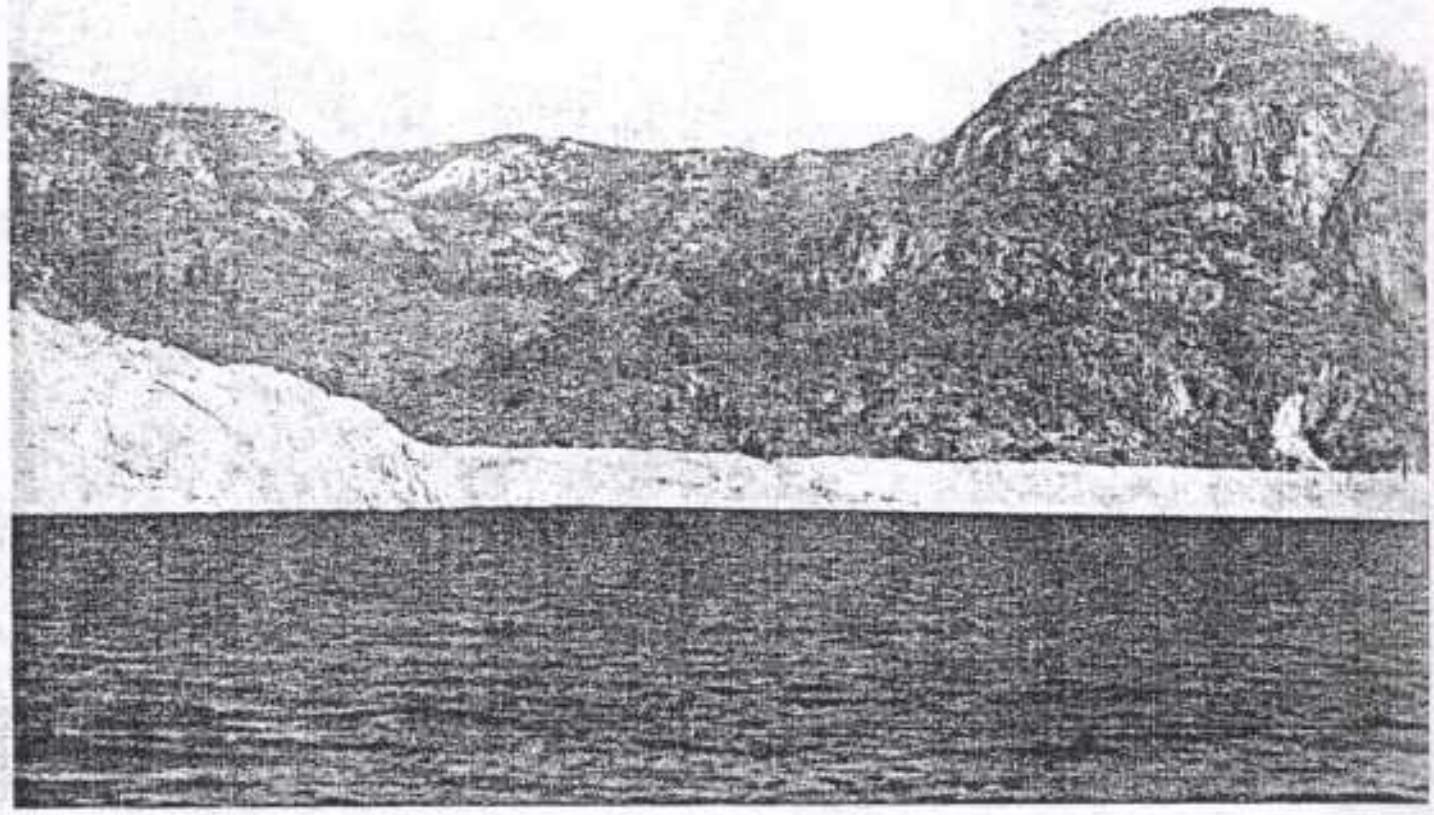
Upper River Canyon Area

The upper canyon area is, more or less, straight: the top of Kolana can be seen from many places in the canyon.

As shown in Exhibit 13, the most impressive features of the upper canyon are the huge vertical distances that are visible. The walls are extraordinarily high, rising 3,900 feet on the south side and 2,700 feet on the north side. The walls are very steep and have significant amounts of glacially-polished granite. The most significant granite structure is the enormous "Battleship" which rides high on the south wall. The canyon is mostly a typical "V" shape, although the bottom is "U" shaped and quite wide in places. At the upper end of the reservoir, the width is about 600 feet wide. The canyon is awesome.

The exposed bottom of the upper reservoir has about six inches of sandy-silt sediment, indicating that the sedimentation rate is minimal. Ponderosa pine stumps line the barren river. These widely spaced trees were 75 to 200 years old when they were cut, based on tree ring counts. See Exhibit 14.

The bottom of the canyon rises slowly as the visitor travels towards the upstream end of the reservoir. At low water, several rapids can be seen in the last mile. There are a series of falls at the head of the reservoir. The canyon turns left and the natural canyon is visible.



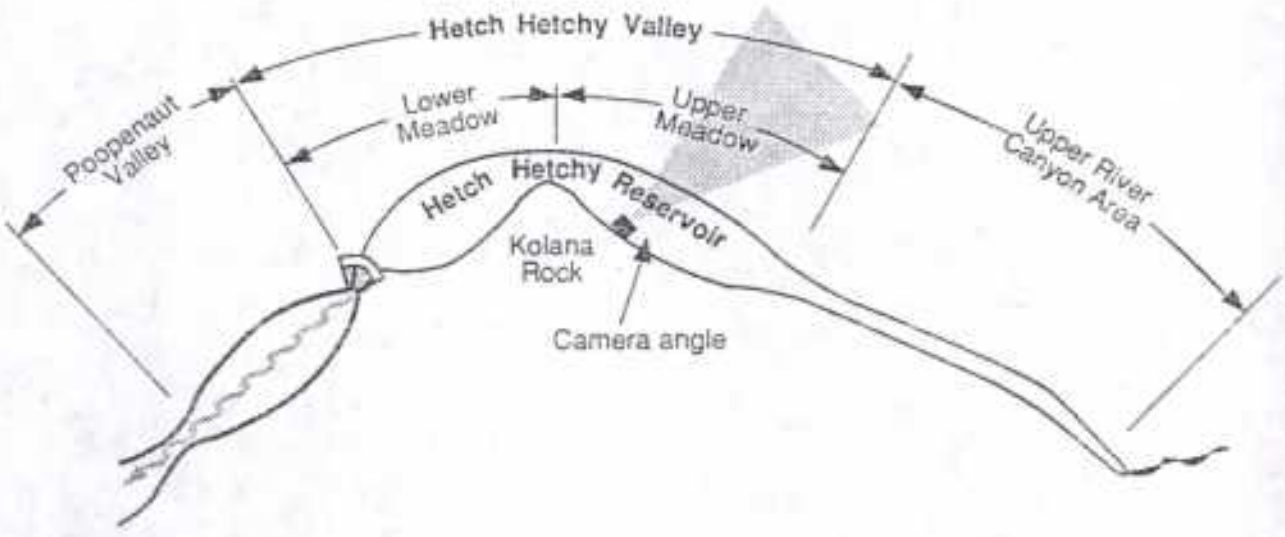
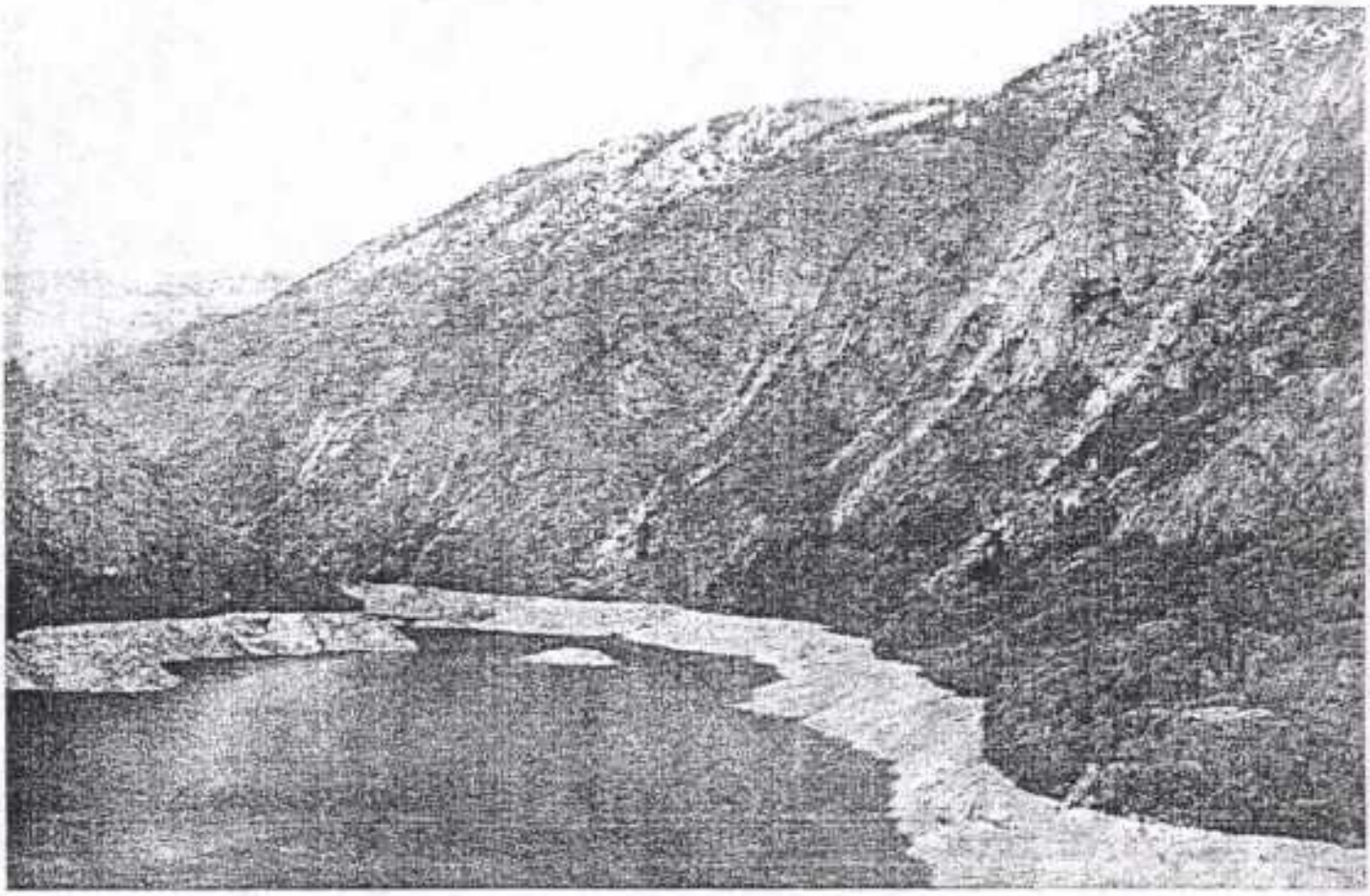


Exhibit 12
The Rancheria Creek Gorge



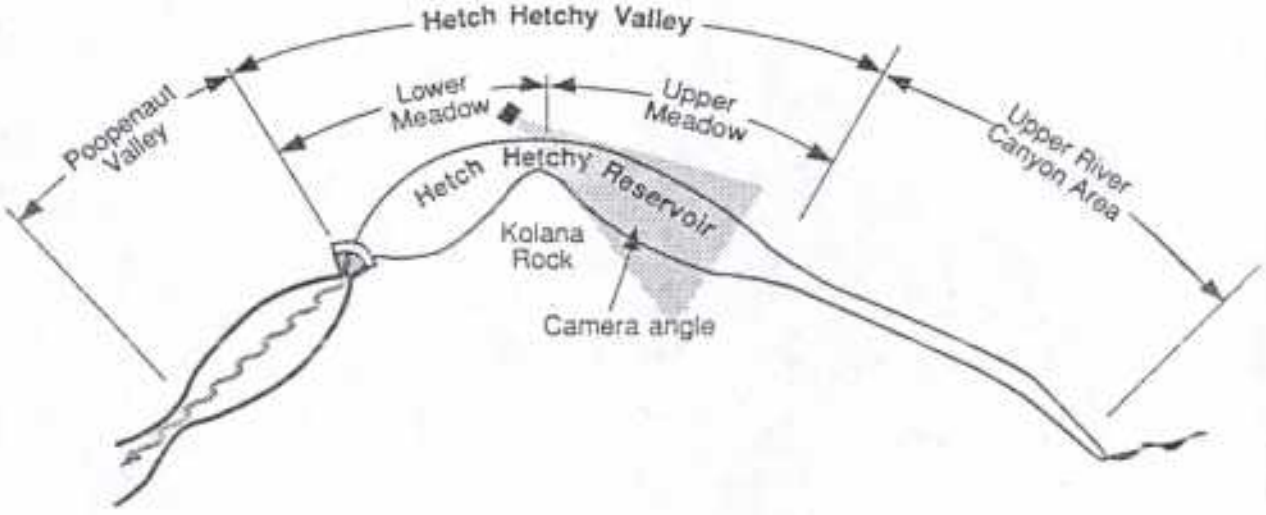


Exhibit 13
South Wall

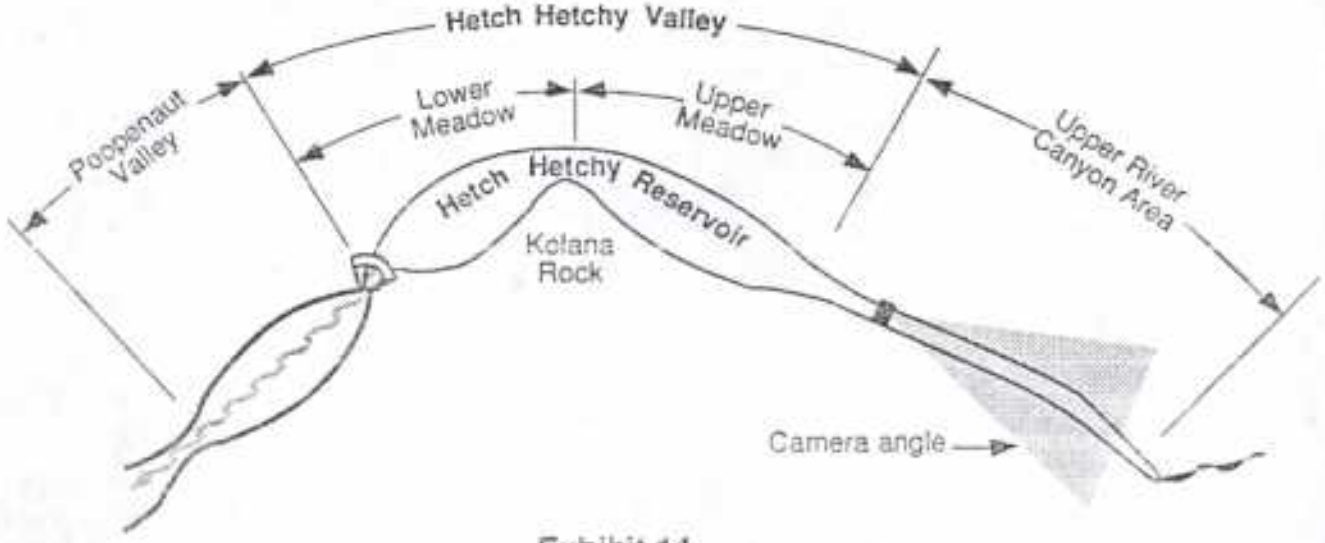


Exhibit 14
Upper River Canyon
Tree Stumps Exposed at Low Water

Chapter 3

COMPARING HETCH HETCHY & YOSEMITE

Comparing anything to Yosemite, one of the geological and scenic wonders of the world, is both unfair and a great compliment.

Size

The outer lines on Exhibits 15 and 16 show the shapes of the two valleys at an elevation 500 feet above the valley floors. The shape of Hetch Hetchy also includes the upper river canyon area, part of which was inundated by the reservoir. As can be seen from the exhibits, the general outlines of the two valleys are not similar. Yosemite is 10 miles long from the Cascades to Nevada Falls. Hetch Hetchy is 3.5 miles long, with another 3.5 miles of upper river canyon. Thus, Hetch Hetchy Valley is about one-third the length of Yosemite Valley.

The shaded areas of these two exhibits show the shapes and extent of the flat valley floors. Again, Hetch Hetchy is about one-third the size of Yosemite.

Vertical Scale

Yosemite's walls rise about 3,200 feet above the valley floor. Hetch Hetchy's walls are more variable in elevation, but are in the same range as Yosemite's. Yosemite's walls are steeper. Yosemite's highest domes and peaks are significantly higher than Hetch Hetchy's.

Vegetation

The vegetation of the Yosemite floor has been significantly altered by human activities. A century ago, Yosemite contained more extensive meadows because the valley had a higher water table, i.e. the ground was wetter. The wetness was not suitable for many varieties of trees. The primary trees were of the pine-oak woodland types. Around the turn of the century, the state's Yosemite Commission dynamited the remnants of the glacier's terminal moraine which had restricted water flow out of the valley. When this "dam" was removed the river was able to cut deeper into the valley floor and, as a result, the water table was lowered. With drier soil, the meadows were invaded by denser groves of white pines and incense cedar. Thus, the pine-oak woodland is being slowly replaced. The river used to meander more, but now runs in a defined channel which is further constrained by road bridges and their abutments.

Because elevations in Yosemite change so quickly, there is an unusual association of vegetation types that are not often found together. This is one of the factors that makes Yosemite so attractive. Vegetation on the valley floor tends to grow quite large because of the loamy-sandy soils, relatively constant moisture, and protected growing situation. Vegetation on the slopes tends not to grow as large because the soils are thin and granitic, the soils dry out quickly, and the exposure is harsh.

The valley floor of Hetchy Hetchy probably had somewhat similar vegetation to what was originally in Yosemite. Both valleys had wet floors and the unusual associations of vegetation. However, Hetch Hetchy is about 450 feet lower in elevation than Yosemite, making Hetch Hetchy drier and warmer.

Scenic Quality

Beauty is a subjective issue, but Yosemite has many beautiful waterfalls, large granite structures, and meadows. Yosemite has seven long, vertical-drop waterfalls, including Yosemite, Bridalveil, Nevada, and Vernal Falls. Yosemite has many imposing granite structures, including El Capitan, the Brothers, Cathedral Rocks, Half Dome, Sentinel Rocks, the Royal Arches, North Dome, the Washington Column, and others. Yosemite has the Leidig Meadow stretching from the Lodge to the Visitor Center, the Awanhnee Meadow, the El Capitan Meadow, Stoneman Meadow, and the small Bridalveil Meadow. Yosemite has a number of grand panoramic viewpoints: Rainbow View, Discovery View, Inspiration Point, Glacier Point, Yosemite Point, Panorama Point, and others.

Hetch Hetchy does not have the large number of unusual granite structures as does Yosemite. Hetch Hetchy has one major panorama that is exceptionally impressive. Hetch Hetchy's waterfalls are not classic vertical-drop falls, but the volume and noise of

Comparing the Sizes of Hetch Hetchy & Yosemite Valleys

Exhibit 15

Hetch Hetchy

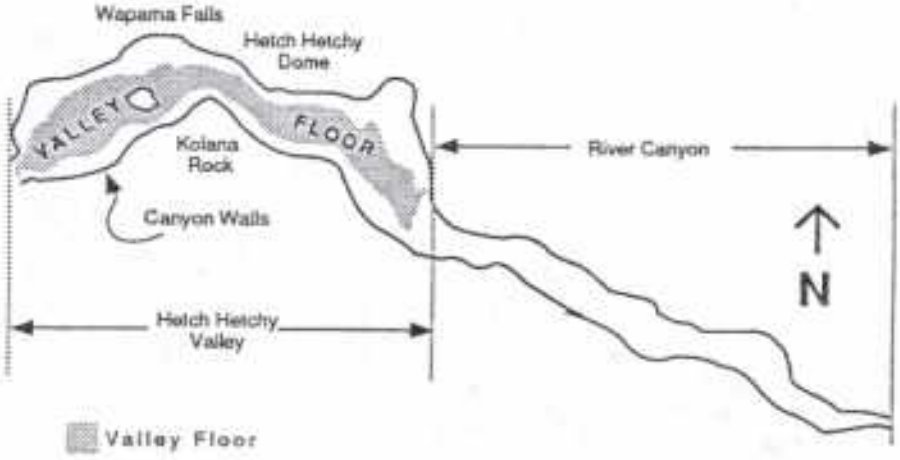


Exhibit 16

Yosemite Valley

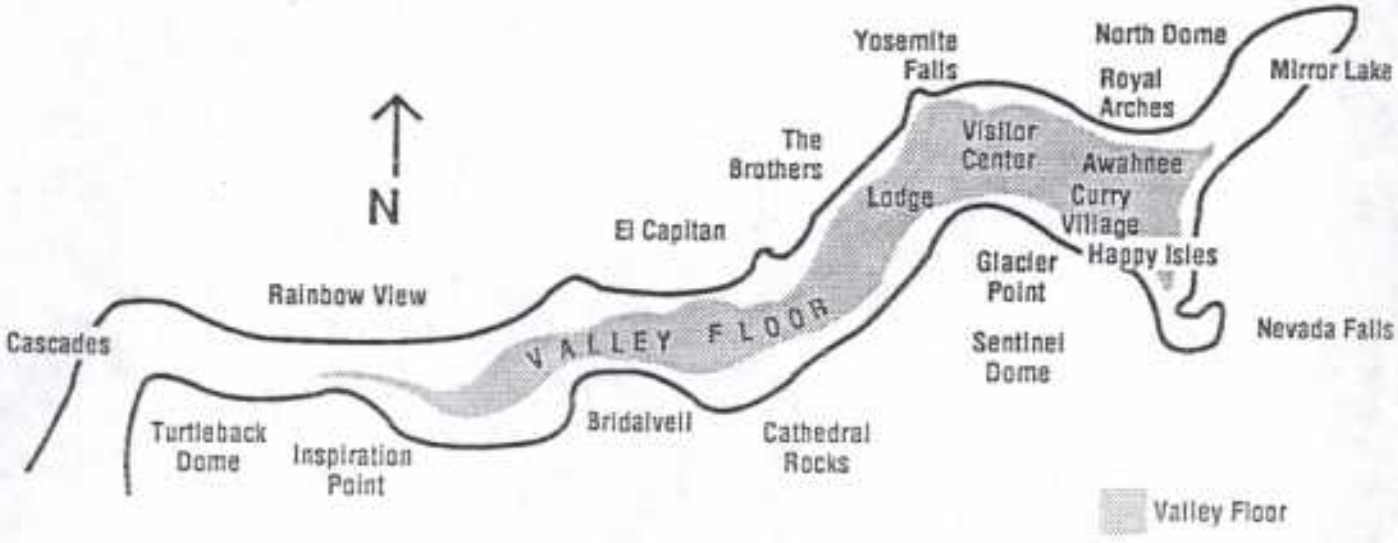


Exhibit 17

Yosemite Facilities in Yosemite

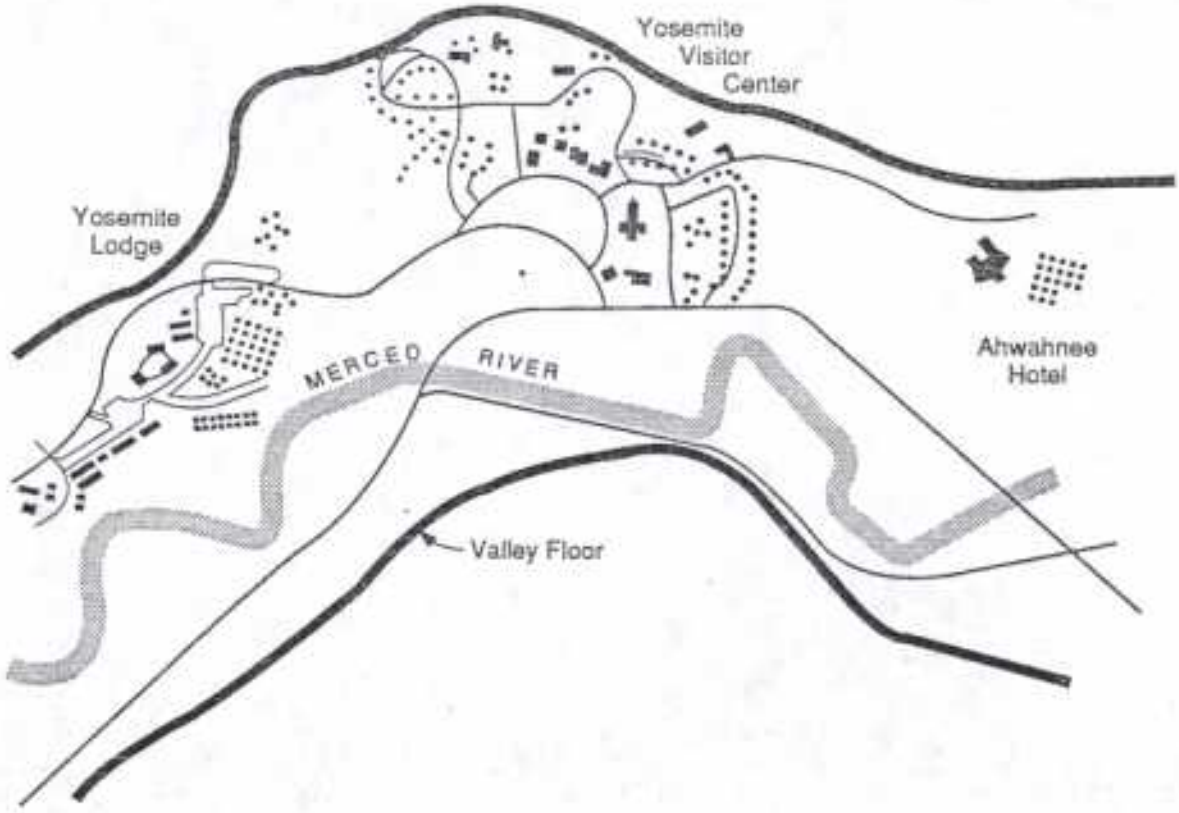
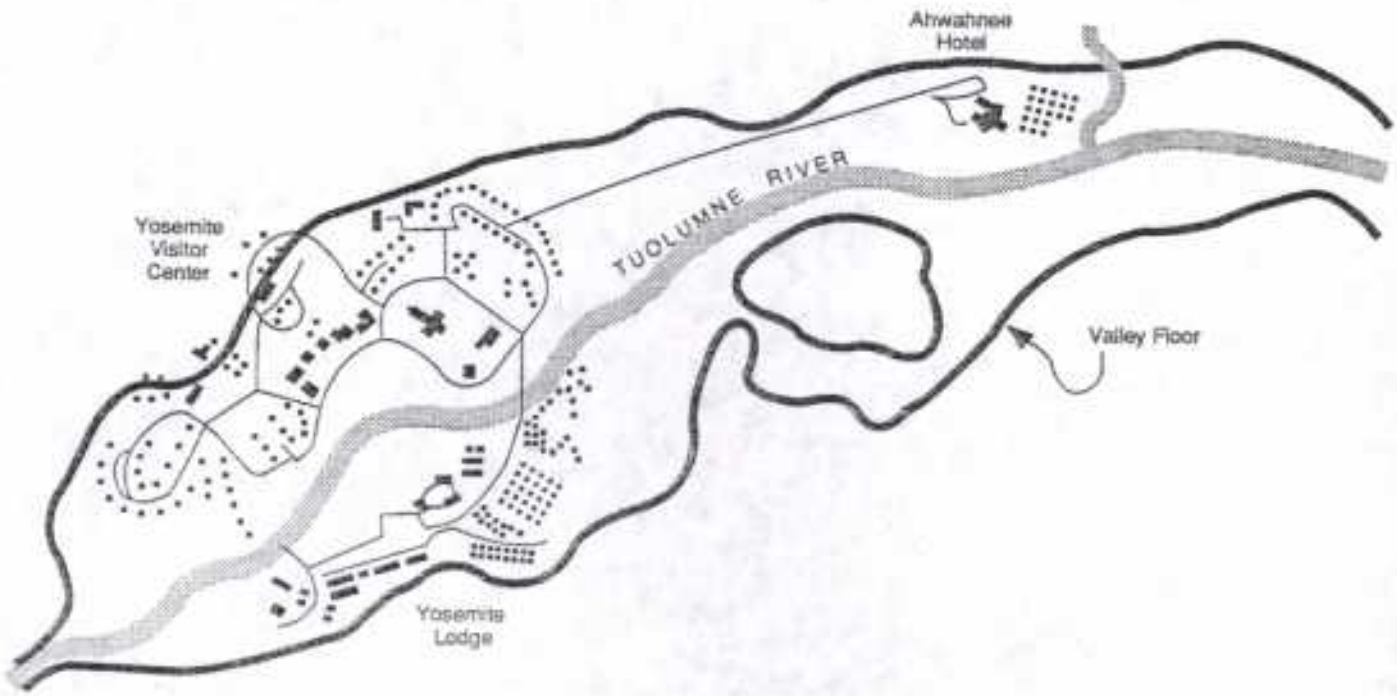


Exhibit 18

How Yosemite facilities would fit in Hetch Hetchy



Wapama makes it much more striking than it appears in photographs. Kolana dominates the valley, but it does not have the grace, drama, and grandeur of Half Dome. Rancheria Creek is unusual and very striking. The walls of the upper canyon are magnificent.

Early Comparisons

In the early days, Hetch Hetchy was overshadowed by Yosemite's grandeur. As an example, a railroad and several roads were built to Yosemite, but not to Hetch Hetchy, even though road building to either would have involved about the same difficulty.

Nevertheless, Hetch Hetchy was given significant praise by some of those who visited it. The following comparisons of the two valleys were made before the controversy over the dam. We are including these to provide a range of aesthetic perspectives.

In descriptions written in 1868, J.D. Whitney, Chief of the California Geological Survey, stated in a report to the State Legislature that the valley is:

> ". . .almost an exact counterpart of the Yosemite . . . It is not on quite as grand a scale as that Valley; but if there were no Yosemite, the Hetch Hetchy would be fairly entitled to a worldwide fame; and, in spite of the superior attractions of the Yosemite, a visit to its counterpart may be recommended, if it be only to see how curiously nature has repeated itself." [8]

In 1879, Lt. M. M. Malcolm stated in a report to the Secretary of War that Hetch Hetchy is:

> ". . . worthy of especial remark as being perhaps the most remarkable feature of the great Tuolumne Canyon. While it cannot be compared with the Yosemite in size or in grandeur, it perhaps more nearly resembles that Valley than any other known locality, and has at least sufficient beauty and individuality to produce an ineffaceable impression on the observer." [9]

T. P. Madden, a member of the State Yosemite Board is quoted in 1883 as saying:

> "It is much smaller than the Yosemite, and therefore, many of its objects are grouped together very grandly and very beautifully, and at once entrance the beholder; but Hetch Hetchy lacks many of the imposing features of the Yosemite. Still, if there had been no Yosemite, Hetch Hetchy would command the admiration of all who visit it, and would probably rank as the grandest and most beautiful aggregation of rock and water in the world — in fact, it would be Yosemite." [10]

In 1885, Zenos Clark wrote:

> "It is one perfectly-cut little gem. Yosemite is a long, strung-out cluster, too rambling and too extensive for a single sweep of the eye: moreover, the landscape-gardening of Yosemite is very rude, it is more like an area of enclosed country with its forests and its rough places, traversed by the Merced River. Hetch Hetchy, on the other hand, makes a picture." [11]

J. H. Quinton, an engineer who evaluated Hetch Hetchy and recommended it as a reservoir site, said in 1899:

> "The rugged granite walls, crowned with domes, towers and spires and battlements, seem to rise almost perpendicularly upon all sides to a height of 2,500 feet above this beautiful emerald meadow which seen from the trail approaching from the east is never to be forgotten."[12]

Chapter 4

RESTORING HETCH HETCHY TO ITS NATURAL STATE

This chapter describes what would occur if Hetch Hetchy were restored to its natural state.

After Hetch Hetchy was drained, grasses would cover the valley floor within one or two years. If moderately-sized nursery trees were planted to partially replicate the original valley, the valley would have a somewhat natural appearance within ten years. The valley would appear natural within fifty years, although experts would be able to note the difference.

If Mother Nature does all the planting, then it would take much longer for a natural appearance. Tree planting would be haphazard and the trees would start as seeds, not as moderately-sized trees. All of the species that were in the valley originally would probably not reestablish themselves because of the lack of seed sources and because oaks are such poor reproducers.

The white "bathtub ring" would disappear slowly as lichen spreads downward from the rocks above.

Recreation

This national "experiment" in restoration would undoubtedly result in a huge number of visitors to the site, not unlike the number of visitors to places where dams are being built.

From a recreational perspective, the valley should be minimally usable within two years and fully usable within ten years if the valley is planted. It is important to recognize that the aesthetic value of the valley is primarily the perspective of the meadows, the high polished-granite walls, and the waterfalls. The trees clearly add to the aesthetics, but they don't have to be 100 years old. In fact, the openness should be beneficial. For example, some of the great perspectives in Yosemite are being slowly obscured by trees due to the removal of the glacial moraine and due to National Park Service's policy of non-intervention in Mother Nature's handiwork.

Removal of the dam would be desirable, but it would be very expensive. There are no estimates of the removal cost at this time. Since the damsite area is not particularly aesthetic, a tunnel could be cut through the bottom of the dam in order to allow river water to flow out. If a roadway into the valley is to be constructed, it should enter at river level from the Poopenaut Valley since any other alternative would require large cuts and long slopes in the Hetch Hetchy Valley. Thus, the tunnel should be large enough to accommodate vehicle traffic.

Another question would be whether to construct Yosemite-like visitor facilities in Hetch Hetchy. For comparative purposes, Exhibits 17 and 18 show some Yosemite facilities in Yosemite Valley and then in Hetch Hetchy Valley. These exhibits make it clear that it would be impractical to put major visitor facilities in the valley. Hetch Hetchy simply doesn't have the space. If major facilities are to be included, the best location would probably be in the Poopenaut Valley or high on the ridge top, either on the road into Hetch Hetchy or high above the damsite on the south side.

To accommodate visitors, a road could be build into the valley and up the river canyon. Private vehicles probably should be prohibited, primarily because of the small size of the valley. Yosemite-type shuttle buses could provide transportation. An interpretive center and cafeteria could be built, probably just upstream of the dam.

The number of visitors going through the Yosemite National Park entrance gates is increasing rapidly, as shown in Exhibit 19.

Exhibit 19

Visitors Entering Yosemite National Park[13]

Year	Visitation
1981	2,616,260
1982	2,506,241
1983	2,549,499
1984	2,842,942
1985	2,922,778
1986	2,982,758
1987	3,266,342

The exhibit shows that the number of visitors is increasing about 100,000 per year. This is about four percent per year, or about twice the growth rate of the state's population. If this four percent growth rate

continues to the year 2000, the Yosemite Park visitation rate will be about 4.5 million visitors per year or 1.3 million higher than today's visitation rate. About 80 percent of this visitation is to the floor of Yosemite Valley. This increase in visitation rates will put significant pressure on Yosemite's resources. Reservations to stay in Yosemite are getting harder to obtain. At peak times in the future, day use in the valley may have to be restricted, possibly through a first-come, first-served system or through a reservation system such as used by the State Parks System for overnight stays.

The National Park Service does not maintain data on the number of visitor-days to Yosemite. After discussions with park personnel, we estimate that the total number of visitor-days is probably about twice the number of visitors, or about 6.4 million visitor-days in 1987. As a comparison, this is about 8.8 percent of the total number of visitor-days at State Parks and is significantly larger than the number of visitor-days at any of the State Park units including the Southern California beaches. The visitor-days at the largest State Park units are shown in Exhibit 20.

Exhibit 20

State Park System Visitor-Days[14]
Largest Park Units
1986-1987

Old Town San Diego State Historical Park	4,805,573
Bolsa Chica State Beach	3,490,126
Huntington State Beach	2,604,066
Folsom Lake State Recreation Area	2,574,195
Carlsbad State Beach	2,300,036
Sonoma Coast State Beach	2,039,242
Seacliff State Beach	1,824,216
San Buenaventura State Beach	1,800,965
Cardiff State Beach	1,667,413
Lake Perris State Recreation Area	1,536,624
Half Moon Bay State Beach	1,378,555
Big Basin Redwoods	1,246,775
Morrow Bay	1,193,224
Mt. Tamapais	1,165,934
Hearst San Simeon State Historical Monument	1,049,780
Leo Carrillo State Beach	1,044,456

The number of visitors to the Hetch Hetchy area is currently about 40,000, or about one percent of the visitation to Yosemite National Park. Since most of the visitors only stay a short while to see the dam, the real use of the area is very small. If major, overnight visitor facilities are constructed and transportation into the valley is provided, in the year 2000 Hetch Hetchy could handle approximately one million visitor-days per year or about 2,700 per day on average. This would be about 15 percent of the 1987 visitor-days in Yosemite National Park. The additional overnight accommodations would relieve pressure on Yosemite, although many visitors to Hetch Hetchy would still want to visit Yosemite. If only transportation into the valley is provided, the visitation would be less, possibly 600,000 visitor-days per year (1650 per day, on average). This would relieve pressure on day use in Yosemite, but this new attraction would put additional pressure on overnight use of Yosemite and other accommodations outside of the park. If no new facilities are provided other than new parking, the visitation would be still less, possibly 400,000 visitor-days per year (1100 per day, on average).

Chapter 5

PERMISSION TO DAM HETCH HETCHY

To understand the damming of the Hetch Hetchy Valley, it is useful to recognize that the Hetch Hetchy issue occurred from 1900 to 1913, a time when San Francisco was at the height of its political power within the State. For example, in 1900, San Francisco was the most populous county, having 23 percent of the total state population and twice the population of the next largest county, Los Angles.[15]

The Spring Valley Water Company

Early San Francisco was supplied by several private, "for-profit" water companies. Through merger and acquisition, the Spring Valley Water Company secured a virtual monopoly over the city's water supply.[16] The company initially tapped local streams. As needs expanded, the company constructed Crystal Springs and San Andreas Reservoirs in depressions astride the San Andreas earthquake fault in San Mateo County, directly south of San Francisco. Later, the company built water storage and extraction facilities on Alameda Creek, a tributary on the east side of San Francisco Bay, half-way between Oakland and San Jose. Over time, the company controlled 100,000 acres of watershed and reservoir properties in three counties.[17]

The city had many conflicts with the company over monopolistic water rates, outages, water quality, charges for fire hydrant uses, and charges for municipal uses. Similar to what was occurring in many other California communities, the city tried to purchase the company, beginning in 1873.[18] The company wanted $14.5 million, but this was rejected as an excessive price by the city's mayor. One weapon that the city had was the option to develop its own water supply, which would push down the price the company was asking for its assets. In one letter to the company, the city stated:

"The Spring Valley Water Company is also requested to bear in mind that any over valuation of its water system will compel the people of San Francisco to look elsewhere for their water supply. And the withdrawing of San Francisco as a market for the sale of the company's water will reduce the value of the company's lands to what they are worth for agricultural purposes merely."[19]

When the city decided to seek additional water, it had to deal with the state's geography and rainfall. The city was established on the northern tip of a peninsula which is surrounded on three sides by salt water: the Pacific Ocean on the west, the straits of the Golden Gate on the north, and San Francisco Bay on the east. (Refer back to Exhibit 1.) Because of the low precipitation in the mountains around the San Francisco Bay, the city had only a limited ability to supply its water needs from local sources, and many of these were already controlled by others. The most likely sources were in the distant mountain ranges, either northward or eastward. Most of the city's interest was in the Sierra Nevada to the east since the water quality was much better because the rocks and soils of the Sierra Nevada are "hard" and not very erodible.

The city's first effort to obtain its own water supply was undertaken in 1870. This involved a survey of possible water sources such as Clear Lake to the north and Lake Tahoe to the east.[20] In 1875 the city began the process to purchase the Calaveras dam site in nearby Alameda County, which is across the San Francisco Bay. Since the Spring Valley Water company did not want rivals, it bought the site before the city could act.[21]

In 1894, the city published advertisements in the Examiner, Post, and Daily Report newspapers asking for proposals from people who desired to supply the city with water. Among the many replies was one suggesting the Tuolumne River, a crystal clear river about 150 miles due east of San Francisco, part of which was in Yosemite National Park.[22]

Damming the Tuolumne River at Hetch Hetchy

The primary advantages of Hetch Hetchy as a reservoir occurred because the drainage basin and reservoir sites were on public land: (a) the river's high quality water would remain uncontaminated because the drainage basin was within the national park, (b) the water would not require costly filtration if recreational contact was not too extensive, (c) much of the reservoir lands would not have to be purchased because much of the land was in public

ownership, and (d) there would be a diminished likelihood of competing claims from entities such as the Spring Valley Water Company. In addition, the reservoir site was ideal: the reservoir would fill a wide, flat meadow and the damsite itself was very narrow with solid granite walls.

Based on the initial studies, the city proposed a dam at Hetch-Hetchy that would provide about 60 million gallons per day for San Francisco[23] at a cost of approximately $38 million.[24] In 1902 the City asked the Secretary of the Interior, under the 1901 federal Rights-of-Way Act, for the lands needed to construct Hetch Hetchy inside of Yosemite National Park. On June 20, 1903 and again on September 22, 1903, President Roosevelt's Secretary of Interior denied the request.

With growing opposition from the irrigation districts downstream from Hetch Hetchy, the city's Board of Supervisors voted to abandon Hetch Hetchy in 1906.[25] The city renewed its search for alternate water supplies, with all five of the best alternatives involving the American River, which drains the Sierra west of Lake Tahoe and which flows through Sacramento.[26] But, City Engineer Manson appointed himself the chief promoter of the Hetch Hetchy project. He pursued federal approval through Chief Forester Gifford Pinchot, Director of Corporations James Garfield, and eventually President Theodore Roosevelt himself.

President Roosevelt and his predecessors had expanded the National Parks System. It was, however, unclear whether the resources of the national parks were to be protected forever or only protected until they could be wisely developed for the public welfare. As time went on, Roosevelt came under increasing political attack, especially in the West, for locking up too many natural resources. Allowing Hetch Hetchy to be dammed eventually became part of Roosevelt's political strategy to quiet his opponents.

In 1907, the Secretary of Interior resigned and President Roosevelt appointed James Garfield to take his place. Garfield, understanding Roosevelt's political needs, issued the city a permit to dam Hetch Hetchy. The Garfield permit included the following major requirements:[27]

1) The nearby Lake Eleanor damsite, also in Yosemite National Park, had to be developed to full capacity before Hetch Hetchy could be developed,
2) Other cities could join with San Francisco to obtain water from the river,
3) The city could not interfere with the water rights of the downstream irrigation districts, and
4) The city must sell surplus power to the downstream irrigation districts for pumping water.

In 1909, the Hetch Hetchy question became a national controversy: the debate was whether dams should be allowed in national parks and whether to dam Hetch Hetchy. In 1910, President Taft's Secretary of Interior asked the city to demonstrate why the Hetch Hetchy dam should not be dropped from the permit. In response, the city hired John Freeman, a nationally-known engineer from Rhode Island, to prepare an extensive engineering report. Freeman recommended several important changes in the project design that expanded its size and greatly improved its value as a domestic water supply:[28]

1) The system should be designed to provide 400 million gallons per day in order to serve all of the central and southern San Francisco Bay Area rather than to provide 60 million gallons for just the City of San Francisco,
2) Water which was to have been released to the river from Hetch Hetchy, Eleanor, and Cherry Reservoirs should instead be put into long tunnels and then dropped into hydroelectric plants to produce substantial amounts of electricity,
3) The open canals that were to carry the water to San Francisco should be replaced by a closed pipe system in order to protect quality, and
4) The entrance elevation of the long pipe to the city should be kept high enough to force the water to flow by gravity to San Francisco, thereby eliminating the pumping plant needed to pump this water over the coast range mountains.

The Freeman Plan would cost $75 million, but its cost included acquisition of the Spring Valley Water Company system.[29] Freeman also concluded that the terms of the Garfield Permit no longer met the needs of the city.[30] After receiving the Freeman report, Taft's second Secretary of Interior refused to grant the city the rights needed to proceed with the project because he believed that the 1901 Rights of Way Act did not grant him sufficient authority. He believed that only a new congressional act could grant such authority.[31]

In 1913, President Wilson took office and appointed Percy Long as Secretary of Interior. Long had been San Francisco's City Attorney and an ardent

proponent of Hetch Hetchy. By selecting Long, Wilson made clear his intentions for Hetch Hetchy.

In 1913, Congressman John E. Raker, whose congressional district included Hetch Hetchy, introduced HR 7207 to grant San Francisco the right to develop Hetch Hetchy and Eleanor within the Yosemite National Park. HR 7207 eventually included three key political compromises that allowed the bill to pass. These were:

1) Protection for the downstream irrigation districts' water rights, which thereby allowed the districts to support the bill,
2) A requirement that San Francisco use local water sources first, which muted the Spring Valley Water Company's opposition, and
3) A requirement that hydroelectric power that is surplus to the needs of San Francisco must first be sold to the irrigation districts for pumping and to municipalities within the districts' service area.

After two weeks of arguments on the floor of Congress, the Raker Act was passed on December 2, 1913, and signed by President Woodrow Wilson on December 6, 1913.[32]

Following the bill's passage, Utah Senator Reed Smoot, who opposed damming Hetch Hetchy, sent a letter to a key Muir lieutenant, saying that the Raker bill was an administration bill whose passage had been agreed to prior to the election in 1912. Idaho Senator Borah later added the rumor that if the bill did not pass, the President would have sent a special message to Congress demanding it.[33]

Spring Valley and John Muir

But, what of Spring Valley Water Company and John Muir? In 1916 the State Railroad Commission (now the State Public Utilities Commission) was given the responsibility of setting the water rates of private water companies, significantly reducing the conflict between the city and the company. On March 3, 1930, the city finally bought the company for $39.9 million.[34] In 1914, John Muir died, just as work was beginning on Hetch Hetchy. Some say that Hetch Hetchy broke his heart. He was 76.

In the 1930's, the cities of the East Bay decided to build a water project on the Mokelumne River which is two watersheds north of the Tuolumne. Thus, San Francisco was left to be the major water supplier for the San Francisco Peninsula and the South Bay Area around San Jose.

Chapter 6

SAN FRANCISCO'S WATER AND POWER SYSTEM

San Francisco's Hetch Hetchy facilities on the Tuolumne River consist of three interrelated systems:

1). A system to supply water to San Francisco, centered on Hetch Hetchy Reservoir and a tunnel-pipeline system to transport the water from Hetch Hetchy to San Francisco,
2) A hydroelectric power system, centered on Eleanor and Cherry Reservoirs, and
3) A system to assure that San Francisco does not deprive the downstream irrigation districts of water, centered on the downstream New Don Pedro Reservoir.

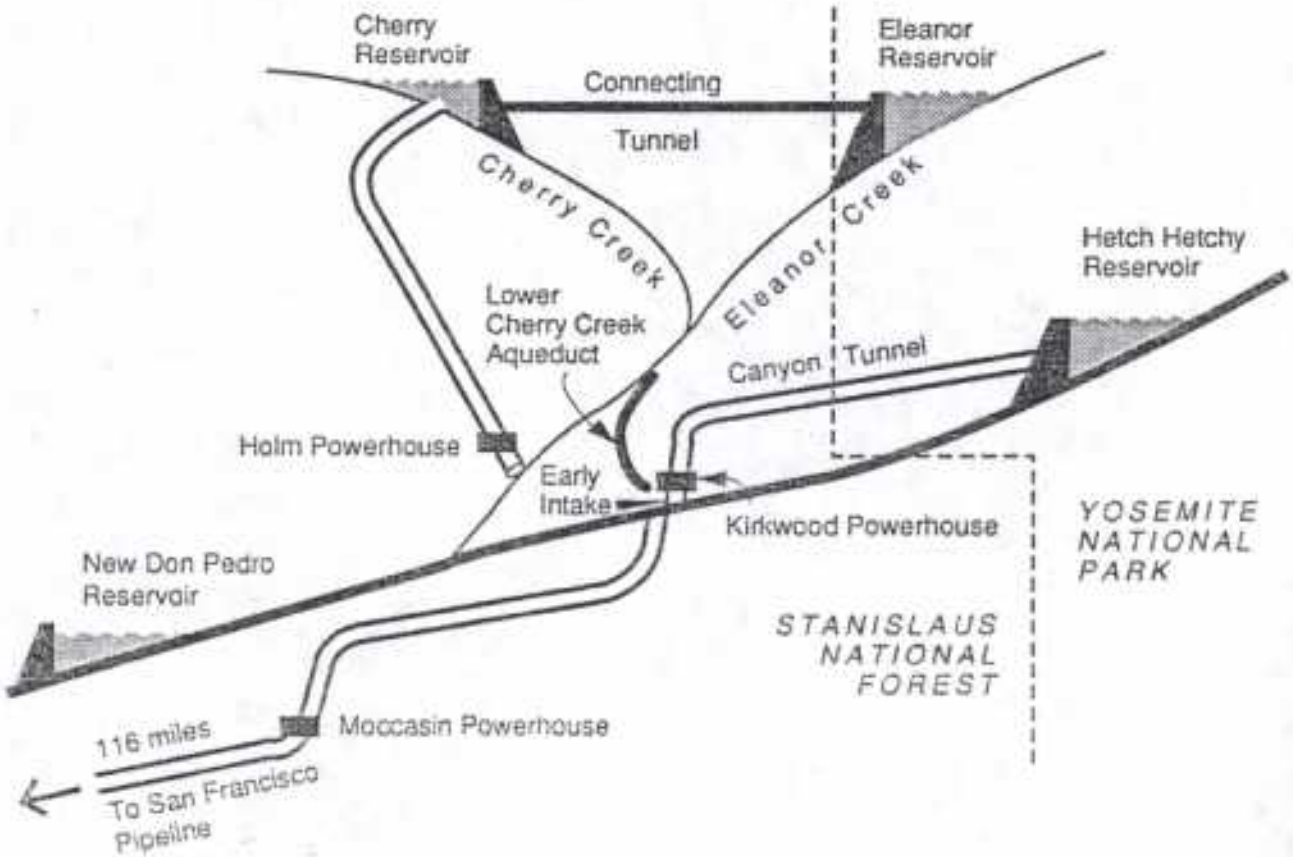
The three systems are shown in Exhibit 21 and are described as follows.

Water System

Hetch Hetchy Reservoir was constructed between 1914 and 1923. Initially, the concrete, gravity arch dam was 226.5 feet high and impounded 206,000 acre-feet of water. The dam was named O'Shaughnessey Dam after the city engineer who was responsible for its construction. In 1938, its height was raised to 312 feet in order to impound 360,000 acre-feet.[35] The dam is 910 feet long, 25 feet wide at the top, and 300 feet wide at the bottom. The dam contains 674,000 cubic yards of concrete and 760,000 pounds of reinforcing steel.[36] A picture of the raising of the dam is shown on the cover of this report.

Exhibit 21

San Francisco's Hetch Hetchy Facilities



Water from the bottom of Hetch Hetchy Reservoir is transported directly to the San Francisco Peninsula for water supply purposes. The water is first diverted at Hetch Hetchy into the gradually sloped, 11-mile Canyon Tunnel. The tunnel flowline is about 80 feet above the original river elevation at the dam.[37] At the end of the tunnel, the water is dropped 1,100 feet to river level in order to go through hydroelectric generators at Kirkwood Powerhouse which is located at Early Intake. The water is then directed into the gradually sloped, 19 -mile Mountain Tunnel. At the end of the Mountain Tunnel, the water is dropped 1,316 feet to the Moccasin Powerhouse. Water used to produce energy, but not needed by San Francisco, is released to the Tuolumne River upstream of New Don Pedro Reservoir. These two powerhouses primarily produce energy on a continuous basis since water is shipped to San Francisco continuously. The water then flows through a 116-mile tunnel-pipeline system to the San Francisco Peninsula after crossing the San Joaquin Valley, going under the Coast Range Mountains, and crossing the southern San Francisco Bay at the Dumbarton Narrows. As recommended by Freeman, Hetch Hetchy water does not have to be pumped to San Francisco; the intake to the tunnel-pipeline system at Moccasin is at a high enough elevation to force the water through the pipeline by gravity.

From 1975 to 1985, the San Francisco water system has delivered an average of 277,000 acre-feet per year,[38] which represents about 6/10ths of one percent of the total water used in California and about four percent of the urban water.[39] Of this, 214,000 acre-feet came from Hetch Hetchy and 63,000 acre-feet came from former Spring Valley Water Company facilities.[40] About 40 percent of San Francisco water is used in San Francisco and about 60 percent is sold to municipal water districts in San Mateo, Santa Clara, and Alameda Counties. The water service area is shown in Exhibit 22. The system supplies drinking water to over two million people.

The current limitation on water deliveries is the 300 million gallons per day capacity of the three water pipelines which cross the San Joaquin Valley. Other portions of the system have a greater capacity. San Francisco water officials predict that additional water delivery capacity will be needed by about 1997.[41]

Power System

The Lake Eleanor Reservoir was completed in 1917, with 27,100 acre-feet of storage. The Cherry Valley Dam was completed in 1956, with 268,800 acre-feet of storage. Water from Eleanor flows through a one-mile-long tunnel to Cherry. The combined water then flows through a six-mile tunnel and then drops 2,100 feet to the Holm Powerhouse, the largest powerhouse in the San Francisco system. This powerhouse is primarily used to meet peak electrical demands. From Holm, water is released to Cherry Creek, a Tuolumne River tributary, at a point about one mile away and eighty feet below Early Intake.[42]

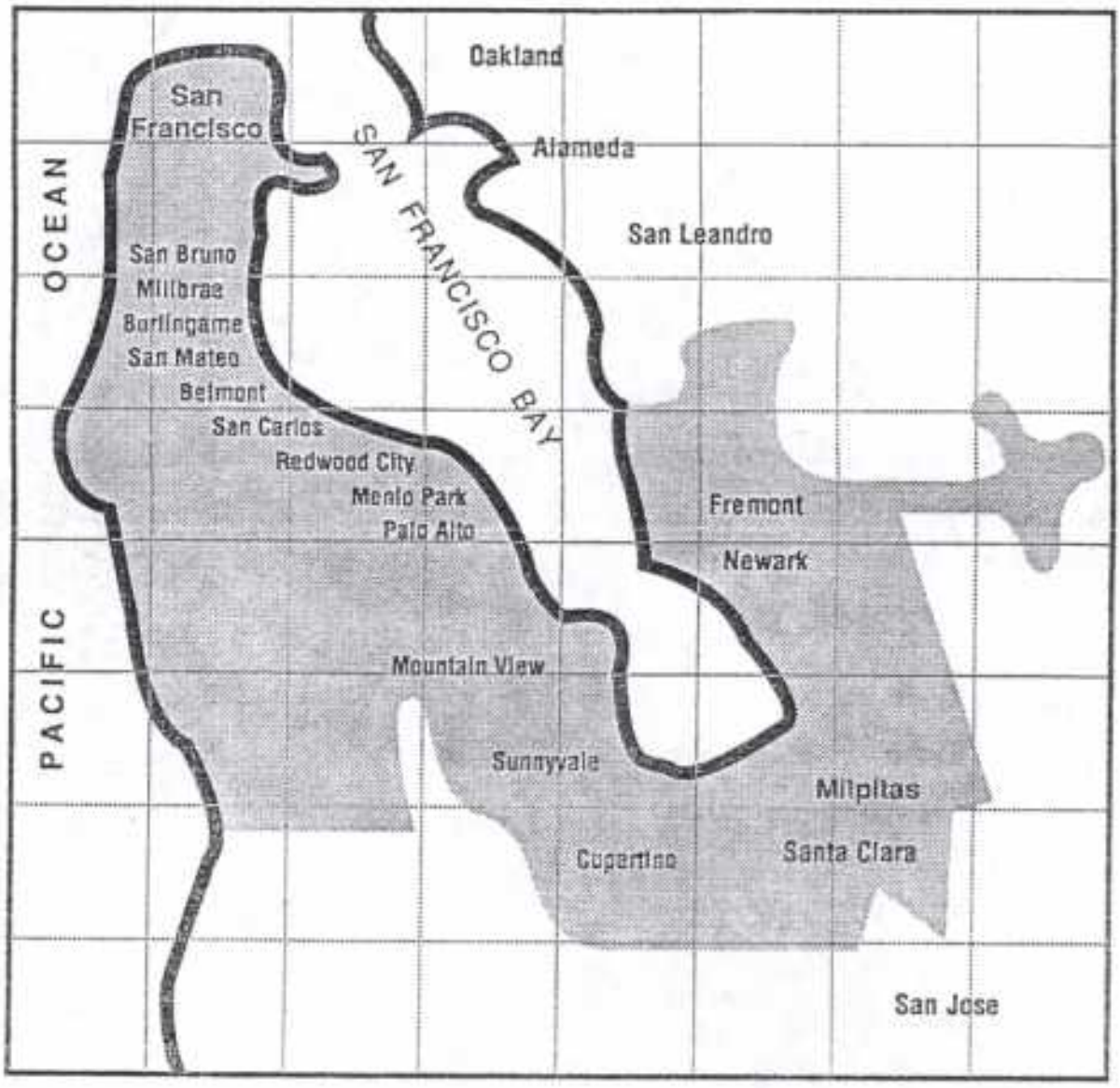
In droughts, some Eleanor and Cherry water can be delivered to Early Intake. To do this, power production at Holm Powerplant is foregone and water is released to the Cherry River and later diverted into the three-mile-long Lower Cherry Aqueduct which conveys the water to Early Intake.

The three San Francisco Powerplants (Kirkwood, Moccasin, and Holm) have a maximum capacity of 368 megawatts and a dependable capacity of 270 megawatts. The three powerplants generate an average of 1.965 billion kilowatt-hours annually.[43] This represents slightly less than one percent of the electricity used in California in a year. Because the city's electrical generation is based on rainfall, which is variable, the city purchases supplemental power from Pacific Gas and Electric Company.

About 25 percent of the city's power is used by the city, 60 percent is sold to the irrigation districts, and the remainder is sold to several large industrial users. Some of the power is sold at the cost of generation (under the terms of the Raker Act) and some is sold at market rates. From 1982 to 1987 the city's power revenue ranged from $60.2 million to $118.6 million per year.[44]

The implications for power were discussed in an undated paper by the federal Department of Energy (DOE) entitled "Hetch Hetchy: Striking a Balance." In the paper, DOE stated that the full market value of the power is about $76 million per year. DOE said that the market value will increase when the surplus in California's electrical generating capacity is ended in the mid-1990's. DOE also stated that the value of the entire system would decline significantly as the system approached the end of its operating life.[45]

San Francisco Water Service Area



Protecting the Irrigation Districts

The Raker Act required that San Francisco not interfere with the water rights of the two downstream irrigation districts: the Tuolumne Irrigation District and the Modesto Irrigation District. The Act specified that the districts are entitled to the first 2,350 cubic feet per second of natural flow except in a 60-day period in the spring when they are entitled to 4,000 cubic feet per second. San Francisco may use and capture flows in excess of those reserved to the districts.

In 1949 San Francisco, the districts, and the Army Corps of Engineers entered into an agreement to construct New Don Pedro Reservoir, which would flood the districts' small Don Pedro Reservoir. This new, very large reservoir would contain 2,030,000 acre-feet of storage. Long-term storage rights[46] in the reservoir are:

San Francisco	570,00	acre-feet
Irrigation Districts	1,120,000	
Flood Control	340,000	
TOTAL	2,030,000	acre-feet

During droughts, San Francisco ships some of the districts' water flowing into Hetch Hetchy to the city. This water is then replaced by water released from New Don Pedro. If necessary, water stored in Cherry and Eleanor is also released to the districts. As evidence of the need for this replacement storage, San Francisco's rights to the Tuolumne during the 1976-1977 drought only amounted to 25,000 acre-feet in 1976 and 2,500 acre-feet in 1977.[47] In the 1987-1988 drought the city's rights were 52,000 acre-feet in 1987 and are estimated to be 0 acre-feet in 1988.[48]

Hetch Hetchy replacement options will be discussed later, but it should be stated that San Francisco has no control of its storage in New Don Pedro Reservoir. Operation of, and water storage in, New Don Pedro is totally controlled by the downstream irrigation districts. San Francisco's water pipelines are however, adjacent to, and in some places under, New Don Pedro Reservoir.

Water Treatment

Hetch Hetchy water in the transmission pipelines is treated with chemicals to reduce acidic corrosion of the pipes. The only public health treatments are the addition of chlorine to kill bacteria and fluoridation to reduce dental decay. At this time, the water is not filtered, although the new federal Safe Drinking Water Act may require San Francisco to filter its water.

Water Quality

Hetch Hetchy water is of very high quality. Since the entire watershed area is within the Yosemite National Park, there are no upstream municipal discharges, agricultural discharges, or landfills which could pose toxic hazards. Exhibit 23 compares Hetch Hetchy water with delta water that is taken into the State Water Project and eventually supplied to 17 million Californians.49 From the exhibit, it is obvious that Hetch Hetchy water is of excellent quality.

Exhibit 23

Comparing the Water Quality of Hetch Hetchy and the State Water Project

	Hetch Hetchy	State Water Project (Measured at Clifton Court)
Sodium (mg/l)	0.93	35.00
Chloride (mg/l)	0.50	42.00
Total Dissolved Solids (mg/e)	14.13	235.00
Conductivity (us)	11.60	339.00
Turbidity (NTU)	.25	14.00
Color (units)	.38	23.00
Asbestos (MF/l)	0.00	209.00

Chapter 7

WATER AND POWER REPLACEMENT ALTERNATIVES

The assumption used in this report for evaluating alternatives to Hetch Hetchy is that San Francisco must be made whole. San Francisco was given permission to construct Hetch Hetchy under the policies of at least two presidents, Theodore Roosevelt and Woodrow Wilson, and by Congress. If San Francisco had been denied, the city would have constructed one of the many alternatives that existed at the time.

There are two problems in considering any replacement alternative: (1) a great deal of knowledge is required and (2) the financial, economic, environmental and operating problems become very complex very quickly. To make the five major alternatives more comprehensible, we will rate each of the alternatives on a scale of one to ten according to the impact on drought storage, divertable water, energy, and downstream recreation. Zero will be the worst case under any alternative and ten will be what exists now.

Readers who want more information on water alternatives should read the Bureau of Reclamation's "Hetch Hetchy: Water and Power Replacement Concepts," dated November 1987.

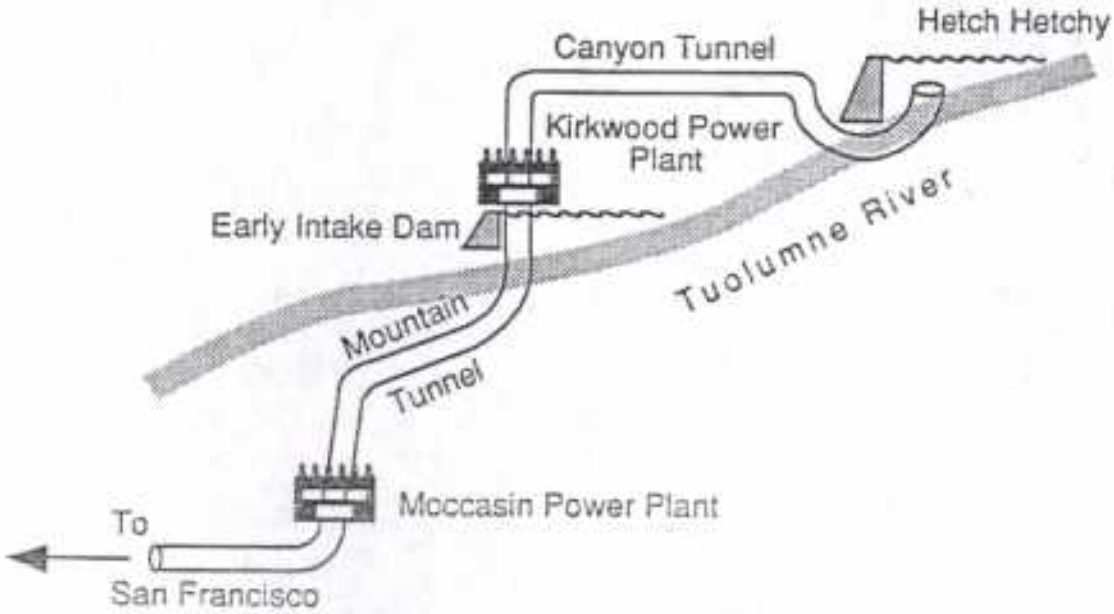
First Consequences of Removing Hetch Hetchy

This section enumerates the first consequences of removing Hetch Hetchy, without considering any actions to compensate for the loss of water and power. Since these consequences are a bit complicated, a schematic of the city's water system is repeated below as Exhibit 24.

From an energy perspective, if Hetch Hetchy is "removed" significantly less energy will be produced. Water would not flow into the Canyon Tunnel because the flow-line of the tunnel is about 80 feet above river level at the damsite. Thus, power production at Kirkwood Powerplant would drop from 615 MKWH to zero. The Bureau estimated that the city would still be able to divert about one-half of Hetch Hetchy water at Early Intake. Thus, power production at Moccasin would drop from 540 MKWH to 270MKWH, a loss of 270 MKWH. For comparative purposes, the current power output of Kirkwood and Moccasin Powerplants is each slightly greater than a full-sized Auburn Dam.[36] The loss of

Exhibit 24

San Francisco Water System



885 MKWH of power (615 MKWH+270 MKWH) would be about $35 million per year at $.04/kwh.

From a water perspective, there are five effects. First, the city's current diversion of about 214,000 acre-feet per year from Hetch Hetchy would drop to about 100,000 acre-feet. Second, San Francisco would lose a 360,360 acre-foot reservoir which equates to 1 1/2 years of drought water supply for the city and its peninsula service area. Third, since the reservoir acts to settle out small rocks and sand, the loss of the reservoir would mean more small rocks and sand would be carried into the pipelines at Early Intake, increasing the wear of the pipeline and the hydroelectric turbines. The loss of 114,000 acre-feet of water at $200 per acre-foot, measured at the dam rather than at the city, would be $22.8 million per year. Whether the existing conveyance system would be reduced in value depends upon the replacement alternative.

From a water quality perspective, the Hetch Hetchy water is so high in quality that the water does not have to be filtered, which saves a significant amount of capital and annual costs. The Congress has enacted a new Safe Drinking Water Act which could require San Francisco to filter its water. If the regulations require all systems to be filtered, then San Francisco would have to filter its water. If the regulations require filtering based on a set of water quality standards, then San Francisco probably would not have to filter its water because its quality is so high. Under virtually any alternative to replace Hetch Hetchy, the replacement water would probably have to be filtered. The capital cost to filter half the water would be on the order of $125 million according to San Francisco.

The total water and energy loss is thus on the order of $57.8 million per year ($35 million for power and $22.8 million for water). This annual loss is equivalent to about $700 million* when expressed as a one-time loss. If San Francisco is not required to filter its water under the new federal Safe Drinking Water Act, then the one time loss increases to $825 million.

In addition to considering water and energy, replacement alternatives need to consider water quality, how the water would get to San Francisco, downstream recreation, and environmental factors.

Replacement Alternatives

Option 1: Use the Power System for Water Supply

From a financial perspective, the first replacement option would be to use the power system (Cherry Reservoir, Eleanor Reservoir, and Holm Powerplant) to supply water to the tunnels which carry water to San Francisco. There are several ways to do this. One way would be to pump water from the output of Holm Powerplant into the Mountain Tunnel. This would restore the energy lost at Moccasin and restore much of the divertable water. As a disadvantage, Holm's energy output would not be as valuable because it would be operating around the clock rather than as a peaking plant. Also, San Francisco would have to filter the water it gets from Holm or water contact recreation would have to be prohibited at Cherry and Eleanor Reservoirs.

San Francisco's reservoirs are essentially capturing the peak flows and releasing these flows over the summer to the river and to San Francisco's pipelines. In the summer, Holm Powerhouse currently releases 800-850 cubic feet per second (cfs) to the river Monday through Saturday from 7:30 AM to 10:30 PM. Fishery flows released from Hetch Hetchy add 110-120 cfs. Thus, the summer flows in the Tuolumne below Holm are 910-970 cfs. Without Hetch Hetchy Reservoir to help regulate flows, the flows between Hetch Hetchy and New Don Pedro would change from a heavily regulated system to a much less regulated situation. This change would have a major adverse impact on river recreational use, which occurs all year, but mostly in the spring, summer, and fall. The recreational use that would be affected the most would be rafting which needs flows between 900 cfs and 6000 cfs. With flows below 900 cfs, the river is too low for navigation because so many rocks are exposed. With flows over 6,000 cfs, the river is too dangerous from a safety perspective.

The average (not median), natural (unimpaired) river flows in the Tuolumne below Holm are as follows:[39]

May	6000 cfs	August	200
June	5200	September	200
July	1600	October	200

* In financial terms, the $700 million is the present worth of the annual revenue loss. In lay terms, it is the amount of money that would would have to be put in a bank to pay the $57.8 million annual loss. Determining the size of the one-time loss is important because it gives us a dollar amount to compare to one-time capital expenditures, such as replacement dams.

Without Hetch Hetchy and using the power system for water, about 700 cfs of the above water would be diverted into San Francisco's pipeline, either at Early Intake or from Holm. If Cherry and Eleanor Reservoirs still have empty storage available, any remaining flows in excess of fishery flows would be diverted to storage, assuming the irrigation district's needs were satisfied. From a rafting perspective, the reduction would effectively reduce flows below the 900 cfs minimum after June. The primary effect upon recreational flows would be to shorten the rafting season and to push it into the colder spring months. In addition, the rafting season would be further shortened because there would be more days when the flows were more than 6000 cfs and rafting is too dangerous.

RATING				
Drought	Water	Power	Recreation	Average
3	8	3	0	3.5

Option 2: Use the Irrigation District Protection System for Water Supply

Hetch Hetchy water that cannot be diverted into San Francisco's tunnels would flow into New Don Pedro Reservoir. If New Don Pedro was not full, the water could be stored in New Don Pedro. After filtering, San Francisco could then pump this water into its nearby pipelines. San Francisco would have to get permission from the irrigation districts to divert from New Don Pedro. This option avoids the adverse impact on river recreation problems.

RATING				
Drought	Water	Power	Recreation	Average
2	8	0	6	4

Option 3: Replace Hetch Hetchy with New Dams on the Tuolumne

Under this option, one or more new reservoirs would be built immediately below Hetch Hetchy in the stretch of the Tuolumne River where river water mostly bypasses the river in pipes on the way to Kirkwood Power Plant.

The first reservoir alternative would flood the Poopenaut Valley which is immediately below Hetch Hetchy. The damsite is excellent: narrow sides and granite walls. A 200 foot high dam would provide about 50,000 acre-feet of storage, about 14% of the capacity of Hetch Hetchy. This site was considered by San Francisco as an alternative to Hetch Hetchy, but was rejected because it offered so little storage. A new tunnel would be built to connect the Poopenaut Dam to a modified Kirkwood Powerplant.

RATING				
Drought	Water	Power	Recreation	Average
2	6	6	8	6

A second reservoir could be constructed just above Early Intake. As a damsite it is poor to miserable. This dam would have to be about the same size as the large Auburn Dam, but its storage would be much less. This dam, in combination with the Poopenaut Dam, offers the best alternative to make San Francisco whole, although this is by far the most expensive option. The Poopenaut Dam and a high dam at Early Intake could totally replace all of the functions of Hetch Hetchy except that only 70% of the energy production would be replaced. Since there would be very little river channel remaining between the two reservoirs, the current fishery flows might be diverted for power. If economical, this reservoir might be connected to the Kirkwood Powerplant.

RATING				
Drought	Water	Power	Recreation	Average
10	10	7	9	9

Option 4: Buy Water from the Downstream Farmers

Under this option, water would be purchased from the downstream farmers. This type of an arrangement was discussed in another Assembly Office of Research Report in 1982 entitled "A Marketing Approach to Water Allocation." Purchasing water essentially replaces the lost storage, but does not address the problem of how to divert the water or how to replace the energy production.

RATING				
Drought	Water	Power	Recreation	Average
10	0	0	6	4

Option 5:
Get Water from Somewhere Else

There are many options to obtain water for San Francisco from sources other than the Tuolumne, but there are usually considerable economic costs, water quality concerns, and physical problems in getting the water to San Francisco. A large Auburn Dam would be a possibility, but the Sacramento region would be very reluctant to have its water go to San Francisco if there could be a future need for that water in the Sacramento region.

Another problem with Auburn and other northern water sources is the question of how San Francisco would get the water: through the existing delta channels, a peripheral canal or a through-delta canal? Using the existing delta or a through-delta canal would mean that the water quality would be degraded substantially in its transit through the delta. In addition, the long term use of the delta for water conveyance is threatened because the delta peat lands are 25 feet below sea level and sinking three inches per year. When the protective levees fail, salt water from the San Francisco Bay will flow into the delta, contaminating the delta supply, possibly permanently. For additional discussion on delta problems, see "California 2000: Paradise in Peril," Assembly Office of Research, 1987.

The best opportunity under this option is probably for the federal Bureau of Reclamation to furnish Central Valley Project water from the delta to where the delta aqueducts cross San Francisco's existing pipelines. The bureau currently has one million acre-feet of delta water that the bureau is planning to market. Replacement power would be furnished by the federal Western Power Administration from federal dams in the northwest. The major problems with this option are that the quality of this water is much poorer, the water would have to be fully treated, the water would have to be pumped from the delta, additional aqueduct capacity from the delta would have to be constructed in the future, and there would be significant costs to resolve the long term problem of conveyance through the delta.

RATING				
Drought	Water	Power	Recreation	Average
?	?	0	10	?

A Replacement Scenario

From the above descriptions of alternatives, it is clear that the various alternatives aren't wonderful. The reality is that in 1913 San Francisco had a wide range of places where it could have gotten its water and power. Today, those alternatives just are not as readily available because others have developed those resources.

The best combination option would be to (1) build the Poopenaut Valley Dam, (2) use the power system to help supply water, (3) either purchase water from the downstream farmers for use in droughts or divert water from New Don Pedro into the pipelines, and (4) replace the rest of the energy by purchase from PG&E, the Federal Western Power Administration, or some other utility. The cost to accomplish this has not been determined, but it undoubtedly will be more than the value of the $825 million loss. The Poopenaut Valley is within the Yosemite National Park and immediately downstream from Hetch Hetchy. The Poopenaut Reservoir's "bathtub" ring would aesthetically damage the Hetch Hetchy restoration. William Colby of the Sierra Club and John Muir grappled with the Poopenaut Dam issue in 1909 and suggested that San Francisco dam the Poopenaut Valley rather than the Hetch Hetchy Valley.[51]

As a comparison of what $825 million can buy, the California State Park System was financed primarily by a series of state park bond acts. These acts provided the amounts of money to the Department of Parks and Recreation as shown in Exhibit 25. The system currently has 287 park units.

Exhibit 25
Funds Provided for State Parks from Bond Acts

Year	Amount
1964	$ 145 million
1970	54
1974	240
1976	244
1980	245
1984	305
Total	$ 1,233 million

Based on $1,233 million used to construct and develop 287 State Park units, it is difficult to justify expending an additional 66% ($825 million) to restore Hetch Hetchy. The State Park System currently has 65.9 million day use visitor-days and 6.9 million overnight visitor-days, for a total of 72.8 million visitor-days. If a restored Hetch Hetchy was developed like Yosemite, Hetchy Hetchy would provide about one million visitor days per year, only 1.4% of the current State Park usage. From another perspective, a restored Hetch Hetchy would make 1,972 acres available for recreation and aesthetic uses at a minimum cost of about $420,000 per acre.

Chapter 8

CONCLUSIONS

John Muir was right: the Hetch Hetchy Valley was gorgeous and would have provided incredible recreational opportunities. San Francisco was also right: the Hetch Hetchy Valley would make an exceptional municipal reservoir site. In 1913, Congress decided that San Francisco was "more" right and the Hetch Hetchy Dam was allowed.

For the people of the 1980's, the issue of restoring Hetch Hetchy involves trade-offs between several very important public needs: recreation, aesthetics, high quality drinking water supplies, hydroelectric energy, and cost. We conclude that the existing Hetch Hetchy system is more valuable to society than a restored Hetch Hetchy:

1. Hetch Hetchy is the best municipal water supply system in the state. The system provides exceptionally high quality mountain water. Because there are no upstream municipal or agricultural discharges, the Hetch Hetchy supply is not faced with the toxic contaminants that plague many other drinking water systems. The value of this water as a drinking water source is very high, financially as well as from a public health perspective. Few communities have such a high quality, toxic free water supply.

The Hetch Hetchy Reservoir provides a drought cycle water supply that is equivalent to 1 1/3 years of water use by San Francisco and the other cities that are served by San Francisco. The Hetch Hetchy system produces 1,965 billion killowatt-hours of hydroelectric energy at three powerplants, each producing more electricity than would be produced by an Auburn Dam. The Hetch Hetchy system provides substantial increases in the summertime flows of the Tuolumne River between Holm Powerplant and New Don Pedro Reservoir. This stretch of the river is part of the Federal Wild and Scenic River System and is heavily used for fishing, rafting, and other types of recreation.

2. A restored Hetch Hetchy would be very esthetic. Being only 14 miles apart, Yosemite and Hetch Hetchy have a similar geologic history: ancient granite valleys carved by glaciers. Hetch Hetchy has vast areas of glacially polished granite, but does not have the large number of magnificent rock structures that Yosemite has. Both have flat valley floors, a river, waterfalls, and great vertical distances. Hetch Hetchy is about one-third the size of Yosemite. Hetch Hetchy is not as spectacular as Yosemite, but has its own exquisite qualities. It is hard to find valleys with such drama, grandeur, scale, and panorama.

Botanically, the original Yosemite and Hetch Hetchy Valleys were probably quite similar. A restored Hetchy Hetchy Valley would have a different vegetative appearance than the current Yosemite Valley because human intervention has resulted in more forested areas on Yosemite's floor. Hetch Hetchy is 450 feet lower than Yosemite, placing it at the lower edge of the foothill-forest boundary. As a result of the elevation difference, Hetch Hetchy is drier and contains a greater percentage of digger pines, oaks, manzanita, and other foothill vegetation types.

If Hetch Hetchy was restored, grasses would fully cover the valley's meadows within two years. With a moderate program to plant large trees, the valley would be recreationally useable within a few years. This is true because the major esthetic values always were the open meadows, the large rock formations, and the "perspective" that is created. Over time, the valley would become more "natural" as the trees grow and as the bathtub ring fades.

The number of visitors to the Hetch Hetchy area is presently a tiny 40,000 per year (110 per day average), most of whom do not travel beyond the dam. Other than a parking lot, bathrooms, a drinking water fountain, and a new walk-in campground, there are no public facilities at Hetch Hetchy. There are a few maintained trails. Most of the area is essentially a wilderness area.

Hetch Hetchy is too small to contain major visitor facilities within the valley as was done in Yosemite. If these facilities are to be provided, they should be outside the valley. If a roadway is to be put into the valley it should enter from a downstream river location in order to avoid the necessity for major road cuts and long slopes within the valley. A shuttle bus system, such as exists in Yosemite, should be used to transport visitors within the valley and within the upstream river area.

If Hetch Hetchy is restored, visitation to the Yosemite National Park will increase significantly

because of the increased recreational opportunities and because of public interest in this "experiment in restoration." If major overnight visitor facilities and a valley roadway system are constructed, Hetch Hetchy should be able to accommodate about one million visitor days per year (an average of 2,700 per day or about 15 percent of the Park's current number of visitor days). This option would decrease visitor pressure on Yosemite Valley by providing an alternative to the types of facilities in Yosemite Valley. If only a roadway system is constructed, the visitation would be less, possibly 600,000 visitor days per year (an average of 1,650 per day). This option would increase overnight visitor pressure on Yosemite Valley facilities. If only minor facilities are provided at Hetch Hetchy, visitation would be still less, possibly 400,000 visitor days per year (an average of 1,100 per day). This option would also put additional overnight pressure on the Yosemite Valley. Under any option, Yosemite Valley would continue to be the major attraction in the park because of its magnificent granites.

3. If Hetch Hetchy is restored, San Francisco would initially lose the following: one-half of the high-quality mountain water that is delivered by gravity to San Francisco without the need for filtering, the sediment settling process that now occurs in the reservoir, one and one-third years of drought storage, and 885 MKWH of electrical energy. The value of the loss, expressed as a one-time cost, is on the order of $825 million. If Hetch Hetchy is to be restored for the greater public good, San Francisco's losses should be replaced.

There are alternatives to replace these losses, but none are attractive because of cost, lower drinking water quality, aesthetic damage, environmental concerns, or adverse impacts on recreation. The water supply can be replaced the easiest, but replacing the water quality depends largely on the alternative. The energy is the most difficult to replace, other than simply buying replacement electricity.

The best economic and environmental replacement alternative would be to use the existing dams on the Tuolumne River and to construct a new dam that would flood the Poopenaut Valley, which is immediately downstream from Hetch Hetchy. This new dam would only be 14 percent the size of Hetch Hetchy, but it has an excellent damsite. The dam would: restore much of the divertable flows during normal times, restore the sediment settling, and replace roughly 50 percent of the lost power. The rest of the power would have to be purchased. The rest of the divertable water could be diverted into the existing water pipelines from New Don Pedro Reservoir or from Holm Powerhouse after the existing power drop from Cherry and Eleanor Reservoirs. The loss of drought storage could be replaced by purchasing water from downstream farmers and then diverting this water through the existing system. To accomplish this, a reservoir operating agreement would have to be entered into by San Francisco, the downstream irrigation districts, and the federal government.

The Poopenaut Dam was suggested as an alternative by William Colby of the Sierra Club with Muir's general consent. The disadvantages are that the reservoir would be totally within the Yosemite National Park, would flood part of a Federal Wild and Scenic River, and would create a large bathtub ring right in front of Hetch Hetchy. When water is being diverted from Holm into the pipelines there would be an adverse effect upon downstream recreation.

4. If $825 million is available to restore Hetch Hetchy, it is quite clear that substantially more recreational benefits could be obtained if the money was spent on other recreational projects. For example, a visitor's experience in the Yosemite Valley could be substantially improved if automobile traffic and air pollution were reduced by the construction of parking lots outside of the valley along with an expansion of the shuttle bus service. As a different example, the six statewide park bond acts (1964, 1970, 1974, 1976, 1980, and 1984) which established most of the financial basis of the California State Park System provided only $1,233 million.

5. The Hetch Hetchy Reservoir has reduced visitor use of the Hetch Hetchy area by making access difficult. In order to mitigate for the loss of recreational uses, we recommend that:

a. A visitor-interpretive center should be constructed near the damsite, preferably with some type of food concessions.

b. An overnight, vehicle campground should be constructed, possibly in the Poopenaut Valley,

c. The existing trail around the north side of the reservoir should be extended to the eastern end of the reservoir in order to accommodate hikers who would use the canyons above the reservoir,

d. If San Francisco constructs facilities to filter its water, boating and fishing from boats should be allowed on Hetch Hetchy Reservoir.

FOOTNOTES

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7. John Muir, "Hetch Hetchy Valley: The Lower Tuolumne Yosemite, " Overland Monthly, Volume 11, July 1873, p. 42.
8. Jones, p. 84.
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10. Jones, p. 85.
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12. F.H. Newell, "Report of Progress of Stream Measurement for the Calendar Year, 1899," U.S. Geological Survey, 21st Annual Report, XXI, part 4 (Washington, D.C., 1899-1900), p. 450-465.
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15. California Department of Finance, California Statistical Abstract (Sacramento, California, 1970), p. 13.
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17. Taylor, p. 174.
18. Taylor, p. 21.
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